THE AMERICAN JOURNAL OF ROENTGENOLOGY
RADIUM THERAPY AND NUCLEAR MEDICINE

VOL. 75 MAY, 1956 No. 5

ROLE OF ROENTGENOLOGY IN THE DEVELOPMENT OF UROLOGY

By N. S. R. MALUF, M.D.
LOS ANGELES, CALIFORNIA

WHAT was the state of genitourinary surgery some sixty years ago before the roentgen rays were discovered? Compared to the present, knowledge was meager. One hundred years hence this will also be said of our own era. Yet in this early day chairs of urology were already established in Austria, Germany, France and America. The first such professorship in America went to Van Buren. It is his name which is attached to steel urethral sounds with a hyperbolic curve of known mathematical formula. His chair was in Bellevue Hospital, New York City, in 1877. Renal, ureteral, and vesical stones and other causes of hematuria were diagnosed with uncertainty. Error was flagrantly frequent. The location of a stone was often missed. Surgical explorations thus lacked precision and frequently, even among the most experienced, were fruitless. Aggressive attempts to extract stones when they could not be felt and were causing no external swelling or suppuration were not made possible by any new diagnostic weapon. Increased surgical daring resulted from the discovery of satisfactory anesthetic agents. To gain insight into how relatively backward the situation was until shortly before the introduction of chloroform and ether, one should turn to antiquity and note the paucity of advance until the past hundred years.

Hippocrates (460–373 B.C.) described signs and symptoms of renal stone and noted advanced pathologic effects as pus formation and swelling in the loin. He recommended warm applications over the kidney and when swelling existed, incision down to the kidney evacuating pus and gravel. Knowledge in this respect advanced only slightly in the next two thousand years. Thus, at the end of the Eighteenth Century and the beginning of the Nineteenth, leading surgical opinion was that removal of renal calculi was indicated only when the stone could be felt or probed in a fistula or when there was marked external swelling.

Extent of function of each individual kidney was unknown. Many deaths resulted from nephrectomy for tuberculosis because contralateral function was unknowingly inadequate to sustain life. The chemist, Berzelius, had presented his figures on a quantitative analysis of urine. Chemical analytical methods were cumbersome and time-consuming. Urea (Rouelle, 1773) and uric acid (Scheele, 1770) were recognized as constituents of urine. The mercurial hydrometer was in use and there was a rough notion about a cor-

relation between renal disease and fixity of the specific gravity of the urine at about 1.010. J. Florian Heller (1852) had introduced his nitric acid test for urinary albumin; Esbach's (1874) reagent for quantitative measurement of urinary albumin was in existence; Bouchardat and Peligot (1838) had established the identity of urinary sugar and glucose. Johann Kjeldahl (1883) presented his method for measuring the nitrogen content of urine. "Blood chemistry" was a clinical impossibility. Thus, in 1902, H. Strauss presented a laborious method for measurement of the nonprotein nitrogen of blood serum. To remove the proteins, he boiled the serum with acetic acid. Little was known about the carbon dioxide content of blood until 1911, when T. Barcroft and J. S. Haldane introduced their gasometric apparatus. The modern era of blood analysis, using samples of 5 ml. or less instead of samples of 100 to 200 ml., had not as yet been ushered in by Otto Folin, Stanley R. Benedict, E. K. Marshall, Jr., and Donald D. Van Slyke.

What diagnostic instruments did the urologist have? Howard Kelly viewed the air-filled female bladder with the patient in the knee-chest position by direct illumination from without through a tube inserted into the urethra. Then in 1880, Thomas Edison introduced the incandescent lamp. Max Nitze (1887) carried this lamp into the bladder at the beak of a tube provided with a system of lenses. The cystoscope was born. Other urologists, Brown, du Rocher, Poirier, and Albarran, designed means of passing cathethers up both ureters through the cystoscope. In 1898, Preston introduced a "cold" or low amperage small lamp for the cystoscope. In 1895, the year that Röntgen discovered x-rays, Howard Kelly introduced the wax-tipped ureteral catheter. Scratches on the wax were diagnostic of calculi in the ureter. This was an extremely useful test and excelled in precision the earlier roentgenograms. Excretion of indigo carmine, which had been used by R. Heidenhain (1874, 1883) in physiologic experiments on the vertebrate kidney, was introduced as a clinical gauge of renal function.

The time was ripe in 1895 for the discovery of the x-rays. Wilhelm Conrad Röntgen's keen observations demonstrated their existence. The very next year T. Macintyre (1896) of Scotland reported the use of voltage from a 6-inch spark coil and a 20-minute exposure for roentgenography of a calculus in the urinary tract. The calculus was confirmed surgically. Before the use of roentgen rays there were only two recognized signs of uncomplicated renal calculi: (1) pain in the renal region, "nephralgia," and (2) gross hematuria, "and by these a good clinician was usually able to say, 'Here is probably a calculus!' " With these words, in the Hunterian lectures for 1898, Henry Morris recorded 44 cases wherein he had failed to find the stone for which he looked. Roentgen rays produced by relatively low-voltage currents ("soft x-rays") in the absence of intensifying screens in the film-holder necessitated exposure times of twelve to thirty minutes. Only large and dense calculi were discernible with such equipment. In 1899, Abbe collected all recorded observations on the detection of renal calculi by roentgen rays. He found only 25 in all. One kidney had been bivalved because roentgenography failed to show the exact site of the calculus in the kidney. This dilemma was solved by T. Edward Burns (1917), who introduced a coordinate method of locating a small calculus in a kidney by measuring its eaxct distance from the edge of the renal shadow. This method, however, was not useful unless the renal shadow on the roentgenogram was distinct.

It soon became apparent that not all shadows of calcific density in the true pelvis were ureteral calculi. Therefore, Tuffier (1897) inserted a lead wire into the ureteral catheter to make the latter radiopaque and thus outline the course of the ureter. This was the first recorded use of a contrast substance in the urinary tract. Klose (1904) used 6 Fr. ureteral catheters in each of which was a very flexible steel mandrin.

Von Illyés (1901) filled the lumen of the catheter with bismuth subnitrate which he considered would permit greater flexibility than a wire of lead, steel, or silver. Fenwick (1905) used a ureteral catheter, the wall of which was impregnated with iron oxide, leaving the lumen open. It was not until 1921 that the value of oblique and lateral projections was recognized (Sgalitzer and Hryntschak) as being useful when doubt existed as to whether a calculus overlying the radiopaque ureteral catheter were actually in the ureter. This method was supplemented by stereoscopic roentgenograms.

The first pyelograms were taken in Berlin by Fritz Völcker and Alexander von Lichtenberg (1905, 1906), who injected a suspension of a proprietary sol of silver, known as collargol, into the ureteral catheters. The renal pelvis was blurred bebecause of the necessarily long exposure time of this early day. They also took cystograms with collargol. Argyrol, a proprietary sol of silver and a protein from serum albumin containing about 25 per cent silver, was used shortly afterward for pyelography (Kelly, 1909). Fifty per cent argyrol yielded satisfactory results but was quite irritating. Intense renal colic, which lasted for days, often followed its use. Uhle, *et al.* (1910), used 50 per cent colloidal silver oxide for pyelography. They stated that renal colic did not occur when the suspension was allowed to flow into the renal pelves through ureteral catheters by gravity from burettes. Kelly and Lewis (1913) used a compound of two densely radiopaque substances, silver and iodine, as silver iodide, in a 5 per cent emulsion. This was as radiopaque as 10 per cent collargol. The silver iodide was suspended in mucilage of quince seed. It was considered bland, antiseptic, and non-irritating and was one-tenth as expensive as collargol. Sterile water was used to wash away the remaining particles from the renal pelvis. In 1916, Zindel collected from the literature a series of cases of severe renal injuries and deaths after the use of colloidal complexes of silver for retrograde pyelography. Burns (1913), of the Brady Urological Clinic at the Johns Hopkins Hospital used 15 per cent thorium nitrate-citrate for retrograde pyelography. This was as opaque as collargol but without its disadvantages. When Cameron (1918) and Rubritius (1920) introduced potassium and sodium iodide for retrograde pyelography the divorce from silver became complete. Cameron stated that 12.5 and 25 per cent solutions are not irritating except on areas of freshly denuded epithelium. He introduced 50 per cent sodium iodide into the renal pelvis of guinea-pigs and 15 per cent into the human bladder without finding any undesirable effect. Rubritius injected 10 per cent potassium iodide until the patient felt discomfort. Eight per cent potassium iodide solution, injected into renal parenchyma of rabbits, did not result in tubular degeneration, necrosis, or inflammation in spite of the creation of an initial circumscribed area of edema before the injection of the potassium iodide. Cameron noted that 15 per cent sodium iodide was more radiopaque than 20 per cent sodium bromide and somewhat more opaque than 15 per cent thorium nitrate-citrate. Sicard and Forrestier in 1922 reported the use of lipiodol for urethrograms and seminal vesiculograms.

The use of a gas as a contrast medium in the urinary tract was first reported by Wittek (1902), who filled the bladder with air and thus demonstrated a bladder stone. Air has been used in pneumograms to demonstrate soft and radiolucent objects in the renal pelvis and ureter since it was reported for this purpose by von Lichtenberg and Dietlen (1911). The use of air in the bladder resulted in several deaths from air emboli. Nevertheless air remains an excellent contrast medium with which to distend the bladder prior to the injection of a fluid radiopaque substance through the urethra for urethrography. Vesical neck stenosis, which may elude examination through the panendoscope, is often recognized preoperatively only by this means.

Masses in the retroperitoneal region can

be brought into relief by the injection of air, oxygen, or carbon dioxide into this area. In 1902, Kelling of Dresden expanded the peritoneal cavity by injecting air into it, thus making peritoneoscopy possible through a small incision. Rautenberg (1914) took roentgenograms of the abdomen filled with air: pneumoperitoneography. Stewart (1920) noted that pneumograms of patients containing injected air, oxygen, or carbon dioxide in the peritoneal cavity showed remarkably clear shadows of the kidneys. Hentzelmann and Eppinger were impressed by their finding that inflation of the colon with oxygen brought the left kidney into relief. As a result of this observation children are now made to swallow fluid prior to intravenous pyelography so that their stomach becomes distended with air, thus throwing the renal shadows into relief. In 1921, Rosenstein and Carelli, independently, injected air, oxygen, or carbon dioxide into the retroperitoneal perirenal space and thus brought into remarkable relief the ipsilateral kidney and adrenal gland. Rosenstein typically injected 500 to 1,000 ml. of oxygen through each flank and considered the method "very easy" and "absolutely safe." He listed the following advantages of pneumoretroperitoneography (PRP): (1) In cases of doubt it will indicate whether a contralateral kidney is present; (2) it will indicate the size-relationship of both kidneys; (3) it will outline stones more clearly; (4) it will show aberrations in shape of the kidney; (5) it will demonstrate tumors of the kidney; (6) it will indicate acute dilatation of a kidney by comparison with the opposite kidney; (7) it will demonstrate tumors of the perirenal region. The principal use of retroperitoneal air today is for the diagnosis of enlargement of the adrenal glands and for other extrarenal masses of the retroperitoneum. Improper use of this method has resulted in several deaths from air embolism. Aspiration should be exerted on the needle prior to every single injection of gas. If aspiration draws the slightest amount of blood this diagnostic test should be cancelled or deferred. Introduction of gas presacrally or retrorectally was introduced by Ruiz Rivas (1948) and elaborated by Blackwood (1951). This route is generally considered safer than flank injection. The same precautions, nevertheless, must be applied.

Technical advances had by then occurred which permitted clearer roentgenograms. Bucky (1913) introduced a grid of interlaced strips of metal directly against the film and between the film and the roentgen tube. This grid reduced scattered roentgen rays. Later the grid was made to move slowly during the exposure. Thus, more distinct roentgenograms over an increased area were obtained. Another advance was the introduction of intensifying screens on each side of the film. These screens may be made of calcium tungstate or barium platinocyanide; they fluoresce when subjected to roentgen rays and thus enhance the sharpness of the image. These improvement and the use of "harder" roentgen rays diminished the necessary exposure time.

Studies of hepatic function showed that certain contrast materials such as tetrachlorophenolphthalein were excreted almost entirely in the bile and concentrated in the gallbladder. Graham and Cole utilized this knowledge in their well-known successful attempt at cholecystography. Satisfactory gallbladder shadows could not be obtained in dogs and rabbits injected with tetrachlorophenolphthalein.Good shadows of the gallbladder were, however, produced by injecting tetraiodophenolphthalein but this drug was too toxic. Tetrabromophenolphtalein was a suitable compromise. Close to that time Rowntree, Osborne, Sutherland, and Scholl, (1923) used 200 ml. of 15 per cent sodium iodide, intravenously and orally, in animals to obtain an excretory pyelogram. Faint pyelograms were obtained but this method was not ventured in man. Rosenstein and von Lichtenberg (1924) repeated the work of the above workers with the addition of perirenal pneumoroentgenography. Johann Volkman (1924) reported the use of various halogen

compounds for excretory urography and found 10 per cent sodium iodide best for this purpose. Lenarduzzi and Pecco (1927) tied off the ureter and injected sodium iodide into animals. They obtained positive roentgenograms of kidney, pelvis, and ureter. Hryntschak (1928, 1929) reported tests for excretory urography with a large series of bromides and iodides in 200 animal experiments. In some experiments he used caffeine, urea, atropine, or pituitary extract to influence dynamics of the renal pelvis and ureter. He obtained positive results in animals as well as in a female patient. Roseno (1928) was the first to obtain practical results with intravenous injection of a compound of sodium iodide and urea, pyelognost, or Na T. Co. $(NH_2)_2$. The results were presented in Berlin before the Deutsche Gesellschaft für Urologie in 1928, where Alexander von Lichtenberg expressed pessimism on the possibility of satisfactory intravenous urography. Roseno's paper would have been given more notice had it not been eclipsed by the report of Arthur Binz on uroselectan (iopax) at the same meeting. Binz's paper was epoch-making because he showed that it was now possible to depict the pyeloureteral system as it actually is. The possibility of a rough indication of the excretory capacity of the kidneys by this means was also shown. Binz's contribution to urography was accidental. In May, 1927, while he was director of the Institute for Chemistry in The Agricultural School in Berlin, he offered Prof. Lichtwitz a pyridine compound, selectan-neutral, which contained 54 per cent iodine. He asked for a clinical evaluation of its effect on streptococcal infections of the gallbladder. The results seemed favorable, but, most important, it was found to be excreted principally by the kidney rather than by the liver. Seventy-five to 80 per cent appeared in the urine in twelve to sixteen hours. The renal parenchyma and urinary bladder of rabbits were visualized roentgenologically after intravenous injection of selectan. The renal pelvis and ureter, on the other hand, were inadequately portrayed unless they had been ligated. In November of 1928 Prof. Lichtwitz observed that selectan-neutral aided in visualization of the urinary tract in the humans he had treated. Prof. Hrynstchak of Vienna (October, 1927) also worked with selectan compounds, including uroselectan, for excretory pyelography, but was not impressed. In 1928, Lichtwitz took his assistant, Swick, to von Lichtenberg of Berlin to discuss the urologic diagnostic possibilities of their new compound uroselectan, which carried 42 per cent iodine and was excreted by the kidneys, appearing in the urine. In 1929, Binz presented uroselectan B, which was much less toxic than uroselectan. Rabbits tolerated over 3 gm. per kilograms. In 1932, the T. G. Farbenindustrie put out per-abrodil (diodrast). The Schering Corporation then put out uroselectan B (neo-iopax) which is even less toxic than diodrast and has 51.5 per cent iodine. Wallingford (1953) struck upon the synthesis of urokon, a tri-iodosodium benzoate with 65.8 per cent iodine and of low toxicity which is outwardly secreted by the renal tubules. Intravenous urography has fulfilled Arthur Binz's prediction in permitting a rough evaluation of renal function and also assisting in the diagnosis of partial or complete urinary tract obstruction, the demonstration of filling defects and other deformities of the renal pelvis and ureter, as well as the emptying power of the bladder without urethral catheterization. Nephrograms obtained immediately after rapid injection of the organic iodides outline nonfunctioning defects within the renal parenchyma.

Physiologists have used diodrast, a standard iodide employed for intravenous urography for the measurement of total tubular excretory volume and effective renal blood-flow. These measurements require maintenance of a steady and known level of diodrast in the blood for one-half hour or longer.

The use of a scanning device over the renal areas for the simultaneous quantita-

tive measurement of radioactive iodine in each kidney after the intravenous injection of radioactive diodrast is the most recently devised renal function test. The contribution of Chester Winter makes possible a determination of the functioning ability of each kidney without any instrumentation other than vena puncture.

The iodides of the pyridine nucleus (iopax, neo-iopax, diodrast, urokon), and skiodan which is a much simpler iodide, have also proved excellent for retrograde pyelography because they possess the following principles within limits of use: They are not irritating to urothelium; not harmful to renal parenchyma; not systemically toxic; are miscible with urine; do not precipitate when mixed with urine, blood or pus; they are of high viscosity, low capillarity and high radiopacity. These compounds have completely antiquated the contrast media of the earlier era: Collargol, argentide, thorium nitrate, sodium bromide, pyelon, lithium iodide, and various iodized oils such as xeroformoil, iodolum, lipiodol and contrastol.

In cysto-urethrography the bladder is filled with air and a roentgenogram is taken as a viscous radiopaque substance is injected through the male urethra. The method is important for defining urethral diverticula, urethral strictures, and stenosis of the vesical neck. The substance first introduced for this purpose viscorayopake (diethanolamine salt of 2, 4 dioxy-3-iodo-6-methyl tetrahydropyridine acetic acid in polyvinyl alcohol) of Coe and Arthur (1946) is no longer on the market. An excellent substitute is 70 per cent urokon thoroughly mixed with water-soluble lubricant in a ratio of 1:1. Roentgenography of the female urethra, because of the shortness of the channel presents difficulties. Nordenström (1952) used an emulsion of barium sulfate in water 1:3 provided that the bladder is thoroughly washed out after the procedure. A fine meshed linked chain lying in the female urethra and demonstrated by roentgenograms in anteroposterior and lateral positions readily reveals the course and degree of angulation of the female urethra. Such studies are especially useful in the problem of female incontinence.

Ordinary cystograms can be obtained with 10 per cent sodium iodide or 25 per cent urokon.

Egas Moniz (1927, 1928) of Lisbon, Portugal, introduced cerebral arteriography as a diagnostic procedure in neurology. Dos Santos and his co-workers (1929, 1931), also of Lisbon, not only followed with the first diagnostic performance of translumbar aortography but astutely observed that adenocarcinoma of the kidney may be diagnosed by the "bloody lakes" indicated by pooling of radiopaque medium in the lesion. Neo-iopax (75 per cent) and urokon (70 per cent) are much safer to use for this purpose than 80 per cent sodium iodide and each offers satisfactory radiopacity. Translumbar aortography is an important method in the differentiation between renal adenocarcinoma and cyst. The latter, however, may include adenoma (probably a precancerous lesion) or abscess, and thus warrants surgical exploration. Pooling of iodide in the kidney indicates the necessity for wide extirpation of the kidney, if possible, without entering the perirenal fascia. The more certain diagnosis gives the surgeon courage to remove the kidney with its perirenal fat and perirenal lymphatic bed intact without surgical exploration of the renal mass before its removal in an effort to differentiate between renal cyst and tumor. Aortography can also demonstrate polar and aberrant renal arteries and indicate the amount of kidney supplied by such an artery (Maluf and McCoy, 1955). The caliber of the renal artery thus revealed is a rough index of the potential function of its kidney. Polycystic kidneys and kidneys with extensive hydronephrosis have narrow renal arteries. Aortography can indicate whether a renal artery is obstructed. Coarctation of the renal artery has been demonstrated by aortography. The presence or absence of a kidney can be shown. The density of the immediate nephrogram following trans-aortic injection of the organic iodide is a good index

of renal function. Cystic areas, as Binz originally observed with intravenous pyelography, may be revealed as negative shadows in the smoothly filled nephrogram. The intra-aortic injection of 70 cc. of 75 per cent urokon causes no deterioration of renal function as measured by clearance techniques. Aortography, properly done under pentothal or local procaine or xylocaine and with an appropriate water-soluble organic iodide (we now prefer 70 per cent urokon routinely), is harmless and essentially painless.

Papillary carcinomas of the kidney, even when advanced, are not revealed by aortography which in such problems may merely exclude adenocarcinoma. Hemorrhage into the kidney from mechanical trauma may show pooling in the aortogram. If this is hemorrhage due to perforation and laceration of the kidney by the wrongly placed aortographic needle, it may lead to unnecessary nephrectomy. Large carcinomas of the adrenal gland and pheochromocytomas may be revealed by pooling in the aortogram. It will be recalled that the pheochromocytoma is a vascular tumor. Pheochromocytomas are frequently spherical. Neither the sympathicoblastoma of the adrenal gland nor adrenal hyperplasia show puddling of iodide. A sarcoma of the kidney may not show puddling but may be differentiated from a cyst by its vascularity.

Caval phlebography, or roentgenography of the inferior vena cava, was used by Fariñas (1947) to demonstrate patency of portacaval anastomosis and by Duff and Granger (1951) and O'Loughlin and Kaufman (1947) for the study of invasion of the inferior vena cava by renal neoplasm. Obstruction of the inferior vena cava is shown by extensive enlargement of collateral venous channels and termination of the shadow of the vena cava at or caudal to the renal veins. Even marked obstruction of the inferior vena cava is not in itself proof of the inoperability of any given tumor nor of extension into the lumen of the vein by tumor. Thus the obstruction in one case was found at autopsy to be due solely to external pressure upon the inferior vena cava by the advancing neoplasm (Maluf and McCoy, 1955). Also renal adenocarcinoma with extension to spleen, diaphragm, and liver need not grossly involve the inferior vena cava. Obstruction of the inferior vena cava may also be produced by carcinoma or sarcoma of the adrenal glands. A caval phlebogram may justly be thought of as a preoperative routine for every probable adenocarcinoma of the kidney. The sedated patient is given 0.25 cc. of the iodide as a test dose against the possibility of sensitivity to iodine as for aortography.

Nephrogram is a term popularized by Hellmer (1942) to indicate intensification of the renal shadow produced by the injection of the various water-soluble organic iodides which are concentrated by the kidney. Alexander von Lichtenberg had noted the intensification of the renal shadow by ordinary intravenous pyelography. Even when a roentgenogram of the kidneys is taken only three seconds after beginning the translumbar aortic injection, the renal shadow stands out intensely. The density of the rapidly appearing nephrogram is a good index of renal function. In cases of congenitally dilated renal pelves and ureters it also serves to outline the extent of the renal parenchyma, especially, when the renal pelvis extends beyond the area of the nephrogram, thus indicating the size of an extrarenal pelvis. Good nephrograms have also been produced by the rapid intravenous injection of 50 ml. of 70 per cent urokon (Wall and Rose, 1951) or 70 per cent diodrast (Weens, *et al.*, 1951). Theoretically, at least, equal amounts of urokon or diodrast should yield more intense nephrograms then neo-iopax because the first two have a much higher renal clearance rate than neo-iopax which is excreted largely by filtration (Smith and Ranges, 1938; Neuhaus, *et al.*, 1949).

The first nephrograms were noted in roentgenograms taken many minutes or several hours after intravenous injection of the iodide, *i.e.*, in delayed exposures. The nephrograms which thus appeared in de-

layed roentgenograms were in patients with acute ureteral obstruction, in which renal function of the affected side was not yet markedly diminished (Lenarduzzi and Pecco, 1927; Wesson and Fuler, 1932; Wilcox, 1935; Weens and Florence, 1947). A cyst or tumor revealed as a vacant space in a nephrogram was first recognized by Hellmer (loc. cit.) while studying patients with acute renal colic by intravenous urography. Leighton (1949) studied artificially produced lesions in the canine kidney by nephrography.

A kidney with an acutely or chronically obstructed ureter will yield a weaker immediate nephrogram than a normal kidney although the delayed nephrogram will be more intense if there is appreciable function left.

Laminagraphy permits roentgen exposure of certain layers of the body eliminating shadows from other layers. This method is especially important when there is much gas in the intestine, for gas may throw a haze of extraneous shadows across the field. The roentgen tube and the film cassette (Bucky tray) are moved in coordinated opposite directions by a two-armed pendulum which swings on an adjustable axis. The upper arm carries the tube and the lower arm the film tray. Objects which are at the level of the fulcrum are in focus of the laminagraph. Clear definition is obtained throughout a thickness of about one centimeter. Laminagraphy was elaborated by G. Grossmann (1935) and used extensively urologically by Jochims (1939). Jochims focused the laminagraph 2.5 to 3 cm. anterior to the tabletop with the patient on his back and obtained satisfactory pyelograms. Bourne and Hefke (1941) suggested focusing at 2 cm. above the tabletop in young children and 3 or 4 cm. in older children. The entire laminagram is somewhat streaky. "The object of body section roentgenography, however, is not to produce a technically improved picture, but to enable the roentgenologist to reveal objects hitherto not obtainable by other methods" (Bourne and Hefke).

Catheterization of the ejaculatory ducts at the seminal colliculus through a cystourethroscope is often a difficult procedure. The location of the orifices may be identified by massaging the seminal vesicles while the urethroscope is in place and noting the point at which the jet of cloudy fluid emerges from each duct. Seminal vesiculograms may be obtained by injecting any of the above pyridine-nucleus iodides through the catheter. A fluctuant boggy "prostate" is frequently found to be a distended seminal vesicle. A differential diagnosis may thus be made.

All in all one cannot but be impressed with the great impact made by the science of roentgenology on the development of urology during the short span of sixty years. It is anticipated that with the rapid progress in the technical construction of roentgen equipment and the further advances in the diagnostic field of urology, even greater strides may be expected in the near future.

4867 Sunset Blvd.
Los Angeles, California

INTRAVENOUS UROGRAPHY

A COMPARATIVE STUDY OF NEO-IOPAX AND UROKON*

By ARTHUR S. TUCKER, M.D., *and* GENO DI BAGNO, M.D.†

CLEVELAND, OHIO

THE importance of intravenous urography in recent years has brought about improvements of techniques for studying the genitourinary tract—improvements that mean greater safety and comfort for the patient and greater diagnostic accuracy for the clinician. Such improvements have been the goal for the development of new contrast media. New contrast media must be evaluated by the radiologist who, through his observations and evaluations of their use, implements the improvements in urographic procedures.

This paper presents a comparative study of two of the available contrast media, neo-iopax and urokon, which were alternately used in 2,000 urograms performed between April 1 and September 28, 1953, at the Cleveland Clinic.

Neo-iopax, disodium N-methyl-3, 5-diiodo-chelidamate, is injected in 20 cc. doses of 50 per cent aqueous solution; urokon, the sodium salt of 3-acetylamino-2,4,6 triiodobenzoic acid, in 25 cc. doses of 30 per cent solution.

The iodine contents of the two media differ percentagewise and gramwise per dose as follows:

	Neo-iopax	*Urokon*
Iodine content	51.5%	65.8%
Iodine content per dose	5.15 gm.	4.935 gm.

Thus, 4.4 per cent more iodine is injected with the average dose of neo-iopax as compared with that of urokon.

METHOD OF STUDY

The investigation of neo-iopax and urokon utilized the plan followed by Mullen and Hughes[1] in their investigation of neo-iopax and diodrast (3,5 diiodo-4-pyridone-N-acetic acid diethanolamine), each of which was administered to 1,000 patients; likewise, similar questionnaire sheets have been used. Moreover, as in the previous survey, in order that the radiology staff might become familiar with the method, a series of 200 patients was injected with the media (100 patients with neo-iopax and 100 patients with urokon), and the results were recorded before the actual survey was undertaken. The urograms were evaluated by 8 radiologists who were unaware of which medium had been used in preparing given films; their interpretations were standardized by frequent consultations with one of us (A.S.T.). The only major change from the approach used by Mullen and Hughes has been the effort to substitute more objective criteria for the grading of the urograms which they listed as "diagnostic quality." Accordingly, all of our films have been evaluated on the bases of demonstration of *renal function* and of *density of medium*.

Intravenous urograms serve, of course, as only rough indicators of renal function. Renal function is rated in 5 categories by number, category *4* having the highest rating: all films having a reasonable quantity of the contrast medium in the kidney, *i.e.*, filling a major part of the calyces or pelvis on the first film five minutes after injection, are arbitrarily assigned a function of *4*. Lesser fillings of the calyces or pelvis are rated on a progressively diminishing scale as *3*, *2*, *1*, or *0*.

In grading density of medium 5 categories also are used, but each probably is more accurately delimited than is the comparable category for renal function. A density of *4* is one comparable to that obtained

* From the Department of Radiology, The Cleveland Clinic Foundation, and The Frank E. Bunts Educational Institute, Cleveland, Ohio.

† Former Fellow in the Department of Radiology, Cleveland Clinic; present address: Children's Hospital of Pittsburgh, Pittsburgh, Pa.

by retrograde pyelography of the particular kidney; *2* represents a density half that great; *0* no density at all, and *3* and *1* the intermediate stages, respectively, greater or less than half the density afforded by a retrograde pyelogram.

With both neo-iopax and urokon, the injections into the antecubital vein were given rapidly, in less than one minute.

Technical failures occurred in the cases of 3 patients of the neo-iopax series and 3 of the urokon series; thus valid observations were obtained in 997 patients of each group. Of the neo-iopax group, in 1 patient all attempts at venipuncture were unsuccessful; another patient became dizzy and shaken after a skin test; and the third patient was a schizophrenic who proved to be entirely uncooperative. In those of the urokon group, 1 patient suffered a psychomotor upset after an intravenous test dose; in another the urogram films were greatly underexposed and the patient refused to have the procedure repeated; and a third patient's case was disqualified from the study because 70 per cent urokon had been administered instead of 30 per cent.

POPULATION GROUPS

No significant differences in age, sex, or race are found between the two groups of patients (Tables I and II). The population of our series corresponds rather closely to that studied by Mullen and Hughes.

TABLE I

AGE RANGE

Age Range (yrs.)	No. Patients Neo-iopax	No. Patients Urokon	Total No. Patients
1–10	20	16	36
11–20	26	20	46
21–30	87	92	179
31–40	181	169	350
41–50	251	238	489
51–60	233	253	486
61–70	164	173	337
71–80	32	31	63
81–90	3	5	8
Total	997	997	1,994

TABLE II

RACE AND SEX DISTRIBUTION

Race	Male No. Patients		Female No. Patients		Total No. Patients	
	Neo-iopax	Urokon	Neo-iopax	Urokon	Neo-iopax	Urokon
Caucasian	479	475	454	469	933	944
Negro	36	20	27	33	63	53
Asiatic	0	0	1	0	1	0
Total	515	495	482	502	997	997

The histories of allergy in the two groups of our series (Table III) do not differ significantly. However, in our series, the incidence of histories of allergy is about twice as high as that reported by Mullen and Hughes. There was a history of allergy in 21.6 per cent of our neo-iopax patients and in 19.4 per cent of our urokon patients; Mullen and Hughes reported a history of allergy in 9.7 per cent of their diodrast group of patients and in 10.2 per cent of their neo-iopax group of patients. The discrepancy is presumed to result from a more painstaking interrogation of the patients in the present series. In the present

TABLE III

HISTORY OF ALLERGY

	No. Patients Neo-iopax	No. Patients Urokon	Total No. Patients
No history of allergy	781	803	1,584
History of allergy	216	194	410
Incidence of various allergies			
Asthma	36	28	
Hay fever	48	40	
Hives	66	73	
Food allergy	63	55	
Drug allergy	40	25	
Rose fever	3	2	
Eczema	8	5	
Contact dermatitis	19	12	
Miscellaneous	4	8	
Total Allergies	287	248	

study, 287 separate allergies were found in the 216 patients of the neo-iopax group who gave histories of allergy; whereas, in the previous series 126 separate allergies were reported in the 102 neo-iopax group of patients who gave histories of allergy.

REACTIONS

"Reaction" is a term having various connotations. Strictly speaking, the term indicates the untoward effects that are caused by the administration of a drug or treatment in a patient who previously had experienced no such effects. In practice, it usually designates only the more serious or dangerous of such effects. In this study, the term has been used in the broader sense, and includes all of the complaints of patients who underwent urography. By our definition, 55.2 per cent of the neo-iopax group of patients and 45.3 per cent of the urokon group of patients experienced reactions. These figures are much higher than those in the Mullen and Hughes series; they reported that 14.7 per cent of their diodrast group of patients and 18.6 per cent of their neo-iopax group of patients experienced reactions. However, it is interesting to note that they reported 6 severe reactions to diodrast and 1 to neo-iopax, whereas we found no severe reactions in either group in our series.

In our series, 50.3 per cent of the patients had one or more complaints, making a total of 1,726 complaints (Table IV). We encountered nearly four times as many reactions in three times as many patients as did Mullen and Hughes. Although more patients experienced reactions from neo-iopax than from urokon, it becomes evident in the breakdown of reactions that the advantage enjoyed by urokon applies only to the local and not to the systemic reactions.

Local reactions include pain at the site of injection, and in the arm or shoulder of the injected side, and are considered to be caused by irritation (whether or not accompanied by extravasation) and venospasm. Local reactions occurred in 123 of our patients in the neo-iopax group, but in only 59 of those receiving urokon. A significant difference in reactions to the two drugs also is found in the incidence of bad

TABLE IV
REACTION TO CONTRAST MEDIUM

	No. Patients Neo-iopax	No. Patients Urokon	Total No. Patients
No reaction	446	545	991
One or more reactions	551	452	1,003
Incidence of Various Reactions			
	Number		
Local			
Pain or burning at injection site	67	41	108
Pain in injected extremity	56	18	74
Systemic			
Bad taste, dry oropharynx	211	132	343
Warmth	169	124	293
Nausea	105	177	282
Dizziness	98	52	150
Flushing	45	58	103
Vomiting	23	47	70
Retching	20	42	62
Paresthesia, face or oropharynx	43	15	58
Coughing	13	21	34
Pallor	12	15	27
Faintness	15	12	27
Sweating	7	10	17
Hives	5	8	13
Sneezing	1	8	9
Pruritus	1	6	7
Pain or burning, abdomen	4	3	7
Chills	6	1	7
Tingling, generalized	5	2	7
Tingling or burning, urogenital	6	1	7
Headache	2	4	6
Dyspnea	3	3	6
Numbness	1	2	3
Palpitation	1	1	2
Tinnitus	1	1	2
Weakness	1	0	1
Swelling or edema, face	1	0	1
Total No. Reactions	922	804	1,726

TABLE V

CORRELATION BETWEEN REACTION AND HISTORY OF ALLERGY

Patients Having One or More Reactions	No. Patients Neo-iopax	No. Patients Urokon	Total No. Patients
No history of allergy	424 (54.2% of 781)	354 (44.0% of 803)	778 (49.1% of 1,584)
History of allergy	127 (58.7% of 216)	96 (49.4% of 194)	223 (54.3% of 410)
Incidence of various allergies			
Asthma	16	17	33
Hay fever	32	18	50
Hives	47	34	81
Food allergy	39	29	68
Drug allergy	24	13	37
Rose fever	0	1	1
Eczema	4	3	7
Contact dermatitis	13	8	21
Miscellaneous	3	4	7
Total No. of Allergies	178	127	305

taste or dryness of the mouth, which frequently is an unavoidable accompaniment of the use of an iodinated drug. With the neo-iopax group of patients it was the most frequent complaint of all, noted in 211 instances, whereas with the urokon group of patients it stood second to nausea and was noted in 132 instances.

General reactions occurred more frequently than local reactions with both drugs. No significant difference in incidence is seen in the two groups, except that nausea, vomiting, and retching each occurred less frequently after injections of neo-iopax than after injections of urokon. The incidence of some reactions is considerably higher than that found by Mullen and Hughes. For example, we have encountered the following reactions to neo-iopax more often: sensation of warmth (169 times in our study to 11 in theirs), bad taste (211 to 23), dizziness (98 to 14), retching (20 to 2) and coughing (13 to 1).

CORRELATIONS OF REACTIONS WITH ALLERGIES AND SEX

In Table v the incidence of reactions is tabulated in relation to a history of allergy. While the percentages of reaction are slightly higher for those having histories of allergy in both groups, the differences are not significant. The absence of a sig-

TABLE VI

CORRELATION BETWEEN SEX AND HISTORY OF ALLERGY

Sex	No. Patients Having History of Allergy Neo-iopax	No. Patients Having History of Allergy Urokon	Total No. Patients Having History of Allergy
Women	123 (25.5% of 482)	125 (24.9% of 502)	248 (25.2% of 984)
Men	93 (18.0% of 515)	69 (13.9% of 495)	162 (16.0% of 1,010)

nificant difference contrasts with the finding in the Mullen and Hughes study that the incidence of reactions was definitely higher in those patients having histories of allergy.

Tables VI and VII present analyses of reactions and of histories of allergy according to the patient's sex, showing the incidence of both factors to be lower in the male. Our findings therefore are somewhat at variance with those of Mullen and Hughes, who, although they also encountered a greater incidence of reactions in women than in men, found almost identical incidences of allergic histories in the two sexes.

SENSITIVITY TESTING

Because of an observed lack of correlation between the results of sensitivity tests and the incidence of allergic reactions, we have abandoned the practice of routine sensitivity testing before injection of contrast medium. Today we perform the sensitivity tests only when the patient is under examination for a specific allergy, or when there is a particularly strong history of allergic reaction. In this study 26 patients were given sensitivity tests, 13 with neo-iopax and 13 with urokon. Twenty-two of the 26 patients were tested with 1 cc. intravenous doses of the media and the remaining 4 were given intradermal skin tests (all 4 happened to be with neo-iopax). All the intravenous tests were negative, with one possible exception. The results in that one exceptional test were doubtful because the faintness and nausea that developed after the injection of the test dose of urokon were believed to be the result of a psychomotor rather than of an allergic response; however, urographic study was not carried out.

Three of the 4 skin tests that were performed gave negative results; the fourth gave a mildly positive reaction. The fourth test was in a patient who six years previously had had a positive skin test, which resulted in abandonment of the contemplated urogram. Because the reading on our intradermal test was so mildly positive, urography was performed, using neo-iopax, and no reaction whatsoever resulted.

One other patient was given a skin test because he had a feeling of dizziness and shaking when he first lay down on the roentgenographic table. Although the test with neo-iopax was negative, urography was not performed because of the patient's apprehensive state of mind.

TREATMENT OF REACTION

Since no serious reactions resulted from the use either of neo-iopax or of urokon, treatment rarely was required for reactions. When treatment was given, it usually was symptomatic, for example, acetylsalicylic acid for headache, or a hot-water bottle applied to an area of extravasation of the medium.

Other medication was given to 7 patients of the neo-iopax group and to 11 of the urokon group of patients. In almost every instance the indication was the appearance of urticaria, accompanied by a greater or lesser degree of pruritus. The

TABLE VII

CORRELATION OF SEX AND REACTION TO CONTRAST MEDIUM

Sex	No. Patients Having Reactions Neo-iopax	No. Patients Having Reactions Urokon	Total No. Patients Having Reactions
Women	320 (66.3% of 482)	240 (47.8% of 502)	560 (56.9% of 984)
Men	234 (45.4% of 515)	214 (43.2% of 495)	448 (44.3% of 1,010)

usual treatment was benadryl (50-mg. tablet by mouth).

Among the patients experiencing urticaria from neo-iopax, 3 obtained rather prompt relief after taking benadryl as prescribed above. A fourth received very little benefit from two successive benadryl tablets, but responded to 0.5 cc. epinephrine hydrochloride 1:1,000 subcutaneously. One other patient had extreme urticaria about his left eye, which he had experienced during previous allergic episodes. Benadryl was not administered because the patient had a history of reactions to that drug. He was given no medication, and the condition slowly improved. Two of the patients were given benadryl prior to the injection of neo-iopax because of a history of previous eruptions. One of these 2 patients had had hives after an earlier "kidney test." She was given a tablet of benadryl before the urogram was made, and the only reaction she experienced was irritation at the site of injection. The other patient, who at the time of examination had a skin rash attributed to three weeks' treatment with "pyridine," was given benadryl, 10 mg. intravenously before the urogram was made, and no further eruption appeared.

Ten patients with hives or other reactions from urokon also received benadryl. All had satisfactory responses to treatment. One of the 10, a patient with a ureteral calculus, is of particular interest because he received the benadryl following the first of two intravenous urograms. He complained on that first occasion of "scratching" in the eyes, itching of the face, and mild sensations of warmth and flushing, all of which disappeared after he took the benadryl. One month later a follow-up urogram was obtained, at which time the warmth and flushing were more pronounced than the first time, but they subsided without any treatment.

One other patient who received urokon complained of warmth, nausea, dizziness, flushing, pain in the chest, and difficulty in articulation. These bizarre reactions were considered to be psychosomatic rather than allergic, but the patient was given 1 cc. epinephrine, and recovered fully.

MULTIPLE EXAMINATIONS

Twelve patients were examined by urography twice during this study. Three of these received neo-iopax both times, 6 received urokon both times, and 3 had injections of each medium. No patient exhibited any significantly different reactions after the two injections. In only 1 patient did the diagnostic qualities of the two urograms differ noticeably. On the first urogram, no density of medium could be identified; at that time the patient had uric acid calculi. Subsequently, a ureterolithotomy was performed, and postoperatively the patient passed a considerable amount of gravel. Seven weeks postoperatively a second urogram showed a density of grade *3* in each kidney. Both of the examinations were performed with neo-iopax.

INTERPRETATION OF UROGRAMS

As previously has been stated, an attempt to achieve more objective evaluation of diagnostic quality of the urograms was made by giving separate consideration to renal function and to density of the medium.

When different ratings were given to the two kidneys on the basis either of renal function or of density of the medium, the higher rating was used in our tabulations. We believe that in most instances, the discrepancy between the ratings of two kidneys of the same person results from factors other than the excreting or concentrating power of the kidney, such as interference by calculi, tumor, infection, or vascular disease.

In both categories, *i.e.*, renal function and density of contrast medium, the ratings of the urograms obtained using urokon were slightly better than those obtained using neo-iopax. On the basis of renal function, the average grade of urokon urograms was 3.9 and that of neo-iopax urograms was 3.8 (Table VIII and Fig. 1); and on the basis of density of contrast medium, the

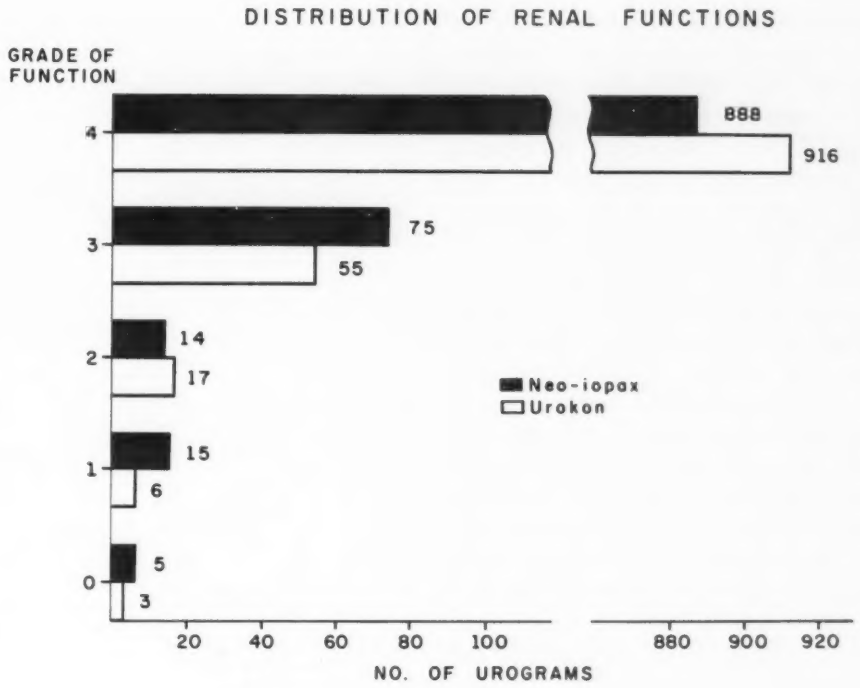

DISTRIBUTION OF RENAL FUNCTIONS
GRADE OF FUNCTION
4
3
2
1
0
888
916
75
55
14
17
15
6
5
3
Neo-iopax
Urokon
20
40
60
80
100
880
900
920
NO. OF UROGRAMS

FIG. 1

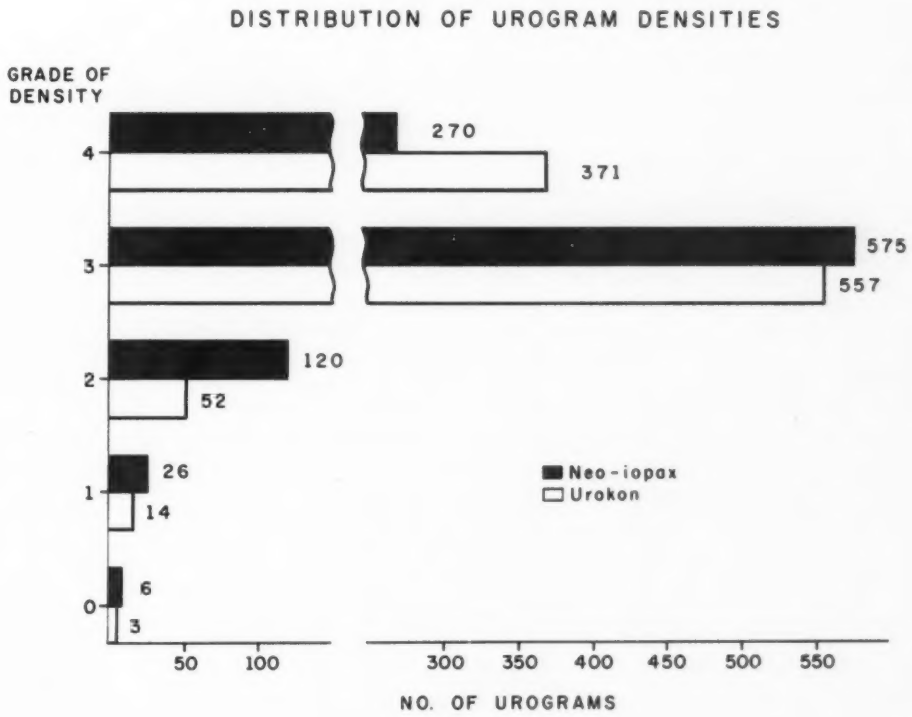

DISTRIBUTION OF UROGRAM DENSITIES
GRADE OF DENSITY
4
3
2
1
0
270
371
575
557
120
52
26
14
6
3
Neo-iopax
Urokon
50
100
300
350
400
450
500
550
NO. OF UROGRAMS

FIG. 2

average grade of urokon urograms was 3.3 and that of neo-iopax urograms was 3.0 (Table IX and Fig. 2). Urokon was found to produce more contrast in urograms in spite of the fact that the iodine content of the intravenous dose was slightly less than that for neo-iopax.

The ratings either of function or of density appeared to have no correlation with the presence or absence of reaction (Tables X and XI), nor with the presence or absence of a history of allergy (Tables XII and XIII). The sex of the patient had no apparent relationship to the rating of renal function (Table XIV). However, the ratings of urograms on the basis of density of medium were slightly higher for the women (Table XV). This difference probably results from the fact that women generally are smaller than men and consequently receive higher doses of contrast medium per pound of weight.

SUMMARY

Neo-iopax and urokon were alternately used for 2,000 consecutive urograms in the Cleveland Clinic to compare the effects of the two contrast media—both clinically and urographically. For each medium, valid observations were obtained on 997 urograms.

A high incidence of reactions was en-

TABLE VIII

GRADING OF RENAL FUNCTIONS

Grade of Renal Function	Neo-iopax No. Urograms	Urokon No. Urograms	Total No. Urograms
4	888	916	1,804
3	75	55	130
2	14	17	31
1	15	6	21
0	5	3	8
Total	997	997	1,994
Average Grade	3.8	3.9	

TABLE IX

GRADING OF UROGRAM DENSITIES

Grade of Density	Neo-iopax No. Urograms	Urokon No. Urograms	Total No. Urograms
4	270	371	641
3	575	557	1,132
2	120	52	172
1	26	14	40
0	6	3	9
Total	997	997	1,994
Average Grade	3.0	3.3	

TABLE X

CORRELATION OF RENAL FUNCTION AND REACTION

Grade of Renal Function	Neo-iopax No. Patients		Urokon No. Patients		Total No. Patients	
	Without Reaction	With Reaction	Without Reaction	With Reaction	Without Reaction	With Reaction
4	393	495	501	415	894	910
3	39	36	28	27	67	63
2	7	7	10	7	17	14
1	3	12	4	2	7	14
0	4	1	2	1	6	2
Total	446	551	545	452	991	1,003
Average Grade	3.8	3.8	3.9	3.9		

TABLE XI

CORRELATION OF DENSITY OF MEDIUM AND REACTION

Grade of Density	Neo-iopax No. Patients		Urokon No. Patients		Total No. Patients	
	Without Reaction	With Reaction	Without Reaction	With Reaction	Without Reaction	With Reaction
4	111	159	195	176	306	335
3	263	312	310	247	573	559
2	59	61	28	24	87	85
1	9	17	10	4	19	21
0	4	2	2	1	6	3
Total	446	551	545	452	991	1,003
Average Grade	3.0	3.1	3.3	3.3		

TABLE XII

CORRELATION OF RENAL FUNCTION AND HISTORY OF ALLERGY

Grade of Renal Function	Neo-iopax No. Patients		Urokon No. Patients		Total No. Patients	
	Without Allergy	With Allergy	Without Allergy	With Allergy	Without Allergy	With Allergy
4	692	196	734	182	1,426	378
3	62	13	46	9	108	22
2	10	4	15	2	25	6
1	12	3	5	1	17	4
0	5	0	3	0	8	0
Total	781	216	803	194	1,584	410
Average Grade	3.8	3.9	3.9	3.9		

TABLE XIII

CORRELATION OF DENSITY OF MEDIUM AND HISTORY OF ALLERGY

Grade of Density	Neo-iopax No. Patients		Urokon No. Patients		Total No. Patients	
	Without Allergy	With Allergy	Without Allergy	With Allergy	Without Allergy	With Allergy
4	210	60	302	69	512	129
3	447	128	442	115	889	243
2	99	21	44	8	143	29
1	19	7	12	2	31	9
0	6	0	3	0	9	0
Total	781	216	803	194	1,584	410
Average Grade	3.1	3.1	3.3	3.3		

TABLE XIV

CORRELATION OF RENAL FUNCTION AND SEX

Grade of Renal Function	Neo-iopax No. Patients		Urokon No. Patients		Total No. Patients	
	Male	Female	Male	Female	Male	Female
4	441	447	448	468	889	915
3	51	24	30	25	81	49
2	8	6	10	7	18	13
1	10	5	5	1	15	6
0	5	0	2	1	7	1
Total	515	482	495	502	1,010	984
Average Grade	3.8	3.9	3.9	3.9		

TABLE XV

CORRELATION OF DENSITY OF MEDIUM AND SEX

Grade of Density	Neo-iopax No. Patients		Urokon No. Patients		Total No. Patients	
	Male	Female	Male	Female	Male	Female
4	102	168	140	231	242	399
3	297	278	306	251	603	529
2	93	27	38	14	131	41
1	17	9	9	5	26	14
0	6	0	2	1	8	1
Total	515	482	495	502	1,010	984
Average Grade	2.9	3.2	3.2	3.4		

countered: 55.2 per cent from neo-iopax and 45.3 per cent from urokon; none of the reactions was serious. The chief differences between the types of reactions from the two media are: neo-iopax caused more local reactions (pain, irritation); whereas urokon caused more systemic reactions (nausea, vomiting, retching).

Histories of allergy were more frequent among women (25.2 per cent) than among men (16.0 per cent); and reactions had somewhat similar percentage ratios among the sexes, occurring in 56.9 per cent of the women, and in 44.3 per cent of the men.

Sex, race, history of allergy, and reactions of the patient to the contrast medium exerted no significant effects upon the diagnostic quality of the urogram.

Comparable diagnostic studies were obtained with both media. The ratings of urokon urograms on the basis of demonstration of renal function were slightly higher than those of neo-iopax; they were significantly higher than those of neo-iopax urograms on the basis of density of contrast medium.

Arthur S. Tucker
Cleveland Clinic
Cleveland 6, Ohio

REFERENCE

1. Mullen, W. H., Jr., and Hughes, C. R. Intravenous urographic contrast media; controlled study of diodrast and neo-iopax. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., 1952, *68*, 903–914.

Vol. 75, No. 5

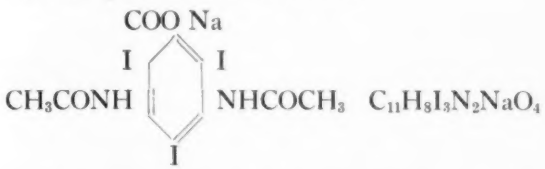
A REPORT ON HYPAQUE, A NEW INTRAVENOUS UROGRAPHIC MEDIUM

SERIES OF 800 CASES*

By M. EUGENE SPEICHER, M.D.
NEW YORK, NEW YORK

THE perfect parenteral urographic medium would be one which would yield urograms comparable to instrumental urography in brilliance and delineation of anatomic details, yet it would remain inert, cause no side effects, and be rapidly excreted by the kidneys. Hypaque is presented as a compound which causes minimal side effects while producing urograms as good as or better than those obtained with other urographic agents in contemporary use. This report is based on 800 consecutive intravenous urographies performed at Squier Urological Clinic using hypaque as the excretory urographic radiopaque medium.

Hypaque, a commercial preparation of the Winthrop Stearns Laboratories, is sodium 3-5 diacetamido 2-4-6 tri-iodobenzoate. It is a white crystalline solid with a molecular weight of 636 and is highly water soluble. The iodine content is 59.9 per cent and hypaque comes in 30 cc. ampules as a 50 per cent solution. It has the following structural formula:



$C_{11}H_8I_3N_2NaO_4$

Excretory investigations in laboratory animals have demonstrated rapid renal excretion of the drug in the unchanged form. Studies in dogs have shown that in six hours, 88 per cent of hypaque has been excreted into the urine, 66.5 per cent being excreted in the first two hours after injection. Determination of acute intravenous toxicities in laboratory animals have shown hypaque to have an LD_{50} in cats of 11,300 mg./kg., whereas under identical laboratory conditions, sodium acetrizoate had an LD_{50} of 5,650 mg./kg.

The patient's preparation and the roentgenographic technique were not altered from the procedure followed with the use of other contemporary urographic agents. An eighteen hour dehydration period prior to urography was the sole patient preparation. An intradermal skin test with 0.1 cc. of the medium was done fifteen minutes prior to intravenous injection; no hypersensitive skin reactions were observed in this series. The intravenous injection of 30 cc. of a 50 per cent solution of hypaque was made into any suitable vein, generally an antecubital vessel, in a period of time between thirty and one hundred and eighty seconds. In patients with a history of allergy or drug sensitivity, it was found preferable to give the injection in a period of time not less than two minutes. The urograms were taken at ten, forty and seventy-five minute intervals after intravenous injection, using a modified compression technique. With normal renal function and unobstructed urinary tracts, the best images of the upper urinary tracts were obtained on the ten minute films. However, with impaired renal function and with obstructive uropathy, the delayed films yielded the better visualizations. The excretory cystograms were sharpest on the seventy-five minute films. Many seventy-five minute cystograms were so brilliant as to obliterate the negative shadows of bladder filling defects. In such cases the patient was instructed to void and drink two glasses of water. Thirty minutes later an excretory cystogram was obtained with a less dense medium.

The quality of the excretory urograms obtained was graded as excellent, good,

* From the J. Bentley Squier Urological Clinic, Columbia-Presbyterian Medical Center, New York, New York.

TABLE I

QUALITY OF EXCRETORY UROGRAMS

Rate of Injection	Fast 0–60 sec.	Moderate 60–120 sec.	Slow 120–180 sec.	Total
Satisfactory	373 or 85%	258 or 83%	47 or 94%	678
Excellent	58	43	7	or
Good	315	215	40	84.8%
Unsatisfactory	65	54	3	122
Fair	60	49	3	or
Poor	5	5	0	15.2%

fair, or poor. The urograms classified as excellent and good were satisfactory for diagnostic purposes in most cases; those classified as fair and poor were not adequate for diagnosis. (An adequate medium concentration for visualization of the upper urinary tracts is seldom obtained with a blood urea nitrogen value of 40 mg. per cent or over.) An excellent urogram outlined the calyces and pelves as clearly as might be expected with retrograde pyelography and afforded good visualization of the ureters and bladder. Urograms were graded as good when the calyces were incompletely, yet sufficiently filled, so as to yield an impression of normality or abnormality of the pyelogram while providing satisfactory visualization of the ureters and bladder. A fair urogram was one in which there was inadequate calyceal filling to yield a valid opinion of the anatomy of the upper collecting system. A poor urogram showed no concentration of medium in the calyces or pelves, though it faintly outlined the bladder. Table 1 represents the quality of urograms obtained in this series.

Thus, 85 per cent of the excretory urograms were satisfactory for a diagnostic interpretation. It may be seen that the quality

TABLE II

INCIDENCE OF SIDE EFFECTS

Rate of Injection	Fast 0–60 sec.		Moderate 60–120 sec.		Slow 120–180 sec.		Total	
No. of Injections	438		312		50		800	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Side Effects	45	10.3	28	8.8	10	20	83	10.4
Nausea	21	4.8	14	4.5	8	16	43	5.4
Vomiting	12	2.7	7	2.2	—	—	19	2.4
Urticaria	5	1.1	3	1.0	1	2	9	1.1
Tightness in throat	5	1.1	3	1.0	—	—	8	1.0
Hot sensation	4	0.9	3	1.0	—	—	7	0.9
Flushing	—	—	1	0.3	2	4	3	0.4
Faintness	1	0.2	2	0.6	—	—	3	0.4
Dizziness	1	0.2	—	—	—	—	1	0.1
Allergic rhinitis	—	—	1	0.3	—	—	1	0.1
Allergic History	21	4.8	38	8.2	17	34	76	9.5

of the urograms was little influenced by the rate of injection. Representative excretory urograms obtained with hypaque in this series are reproduced.

There were no side effects of major importance. Those that did occur were minor and required no specific therapy. Table II represents the side effects that occurred in this series.

The nausea which occurred in 7.8 per cent of the cases ceased promptly 69 per cent of the time after the patient took several deep breaths; only 31 per cent of the patients with nausea developed vomiting. The urticarial reactions were mild and required no antihistamine. One case of allergic rhinitis developed in a patient with penicillin sensitivity and the nasal passages became occluded with edematous mucosa; the congestion promptly subsided after the ingestion of an oral antihistamine. The 3 cases of faintness developed a transitory hypotension which abated simply on assuming the supine position. The side effects may be summarized as follows: Total intravenous injections, 800; cases with no side effects, 717 = 89.6 per cent; cases with side effects, 83 = 10.4 per cent.

Fig. 1. R. F., female, twelve years old. Ten minute film. Normal urogram.

Fig. 2. C. C., female, fifty-six years old. Forty minute film. Eleven years after three-stage total cystectomy and bilateral ureterosigmoidostomy for recurrent Grade I–II papillary carcinoma of the urinary bladder, demonstrating normal upper tracts and hypaque within the bowel. This patient has been followed with interval excretory urograms since her operation and the urograms obtained with hypaque are more satisfactory than any of those done with other intravenous urographic agents.

It was observed that in the patients presenting a history of allergy, asthma, hay fever or drug sensitivity, the incidence of side effects was increased: Cases with history of allergy, drug sensitivity, etc., 76; cases with no side effects, 64 or 84.2 per cent; cases with side effects, 12 or 15.8 per cent. In 10 patients with a known hypersensitivity to other contemporary intravenous urographic agents (urticaria 9 cases; hypotension requiring adrenalin 1 case), hypaque was used with the development of one side effect (flushing).

It is to be noted that the rate of injection had little influence upon the incidence of side effects.

TABLE III

	Fast 0–60 sec.	Moderate 60–120 sec.	Slow 120–180 sec.
	Per Cent	Per Cent	Per Cent
Side Effects	10.3	8.8	20
Allergic History	4.8	8.2	34

The apparent discrepancy in the incidence of side effects in the group injected slowly is due to the greater incidence of known allergic individuals within that group.

Vein cramp, which is a troublesome side effect with some intravenous urographic agents, was not noted in this series. Extravenous extravasation, however, when it occurred, afforded considerable discomfort, though no tissue slough was noted.

FIG. 3. J. R., male, fifty-five years old. Forty minute film. This urogram demonstrates sharp delineation of anatomic detail by a solitary functioning diseased kidney. The right kidney is a non-functioning "putty" kidney. The left kidney shows pyelographic changes compatible with tuberculosis; the ureter is "beaded," and the bladder shadow contracted and irregular. Excretory urography in similar cases with other urographic agents has usually yielded less satisfactory urograms.

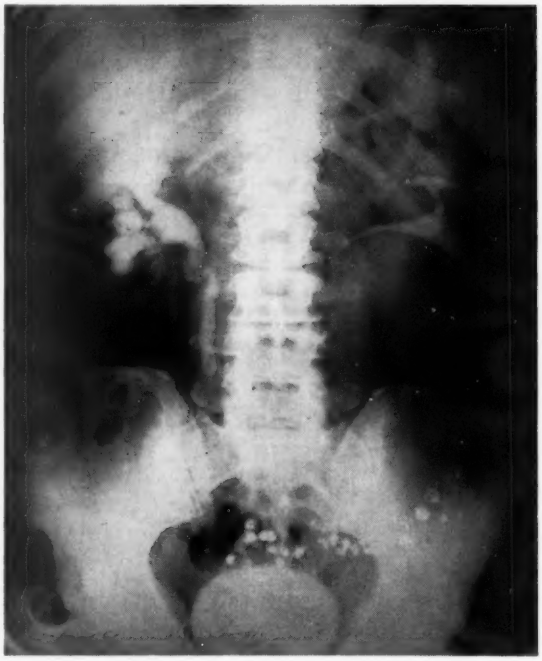


FIG. 4. M. S., male, sixty-eight years old. Seventy-five minute film. A left extrarenal tumor is well outlined by iodide within the pelvis and ureter. The ureteropyelogram of the opposite side is even more brilliant; partial obstruction by a stricture of the mid-third of the right ureter is accompanied with ureterectasis and caliectasis. Diverticula of the sigmoid colon are demonstrated by residual barium from a previous large bowel study. The brilliancy of the hypaque is similar to that of the barium.

SUMMARY

A clinical appraisal of a consecutive series of 800 excretory urograms with hypaque, a new intravenous urographic agent, is presented.

A history of allergy or drug sensitivity is a more accurate criterion for circumspection than a questionable skin test reaction.

The urograms taken ten minutes after injection were the most satisfactory if the urinary tract was normal. The delayed films were superior if renal function was impaired or obstruction was present within the collecting system.

Eighty-five per cent of the urograms were considered satisfactory for diagnostic interpretation.

The rate of injection had little significance in influencing the quality of the urogram or in precipitating undesired side effects.

The over-all incidence of side effects was 10.4 per cent. The side effects were all transitory and of a minor nature.

Ten cases with known hypersensitivity to other contemporary urographic agents developed only one side effect with the use of hypaque.

CONCLUSIONS

Hypaque yields a high percentage of diagnostically satisfactory urograms while causing a minimal amount of minor side effects.

Hypaque may be used in cases with known hypersensitivity to other intravenous urographic agents with a low incidence of side effects.

The Presbyterian Hospital
622 West 168th Street
New York 32, New York

EXPERIENCES IN INTRAVENOUS UROGRAPHY USING HYPAQUE*

By BENEDICT R. HARROW, M.D.

MIAMI, FLORIDA

DESPITE the marked improvement of urographic agents in the past twenty-five years efforts to synthesize and test better compounds are constantly being undertaken. In 1954 a new medium called hypaque† was introduced. This substance contains 59.9 per cent iodine with 3 iodine atoms per molecule. The chemical formula is similar to urokon but contains an extra CH_3CONH radical attached to the identical triiodobenzoate ring. In many animal experiments it has taken about 10 grams per kilogram, a quantity 50 times the usual clinical dose, to produce acute toxicity and death.[6]

Supplied as a 50 per cent solution, 30 cc. of the hypaque was used intravenously in 25 patients and 60 cc. in another 25 patients. The organic iodide was injected slowly over a five to ten minute period without producing arm pain. The slow injection was used since mild side reactions are decreased and since shock-like reactions have been reported after rapid injections of other contrast substances.[2] Only future investigations will reveal whether slow injections are of importance in preventing the severe complications. In this series of 50 patients no side reactions occurred, except occasional mild nausea. There were no flushing, foreign taste, urticaria, thrombophlebitis or shock-like reactions. Of course, larger numbers of patients will have to be reported before a complete evaluation of toxicity can be ascertained. There is one published report of 210 cases with very few side effects.[7]

Shortly after this series of 50 patients a fourteen year old boy with a history of rather severe asthma as a child was given 1 cc. of hypaque intravenously as a test dose and within five minutes developed a fairly severe allergic rhinitis, wheezing, urticaria and periorbital edema. The symptoms subsided within two hours, although not completely for two days, after treatment with an antihistaminic. Although intravenous pyelography was attempted because it seemed extremely important in this case, it illustrates the considerable increase in risk with the use of organic iodides in allergic patients. If it is still elected to perform intravenous urography in these patients despite the known dangers, then certainly appropriate sensitivity tests should be performed even though they are not completely reliable. Probably only one tenth of the 1 cc. of the full strength solution should be given intravenously as a test dose by diluting the original 1 cc. ampule.

The first 50 hypaque pyelograms were compared with 50 others using 25 cc. of 70 per cent urokon (or 50 cc. of 30 per cent urokon) intravenously. The 60 cc. of hypaque resulted in roentgenograms of equal density to those of the 70 per cent urokon. The density with 30 cc. of the 50 per cent hypaque was slightly less on the average than the above series. For routine use 30 cc. is recommended as an adequate amount and only for an occasional patient will it be desirable to use 60 cc. Even though this large quantity is well tolerated, it might increase the chance for a severe reaction. The density or contrast in the above films was superior on the average to those using 30 or 60 cc. of 35 per cent diodrast or 60 cc. of a mixture of 35 per cent diodrast and 50 per cent neo-iopax.[4]

In patients with good renal function who were dehydrated over a sixteen to eighteen hour period and voided urine of high specific gravity just before intravenous pyelography, the specific gravity of the resultant

* From the Department of Urology, Jackson Memorial Hospital and the University of Miami School of Medicine, Miami, Florida.

† Hypaque sodium or diatrizoate sodium (sodium 3,5-diacetamido-2,4,6-triiodobenzoate) supplied by Winthrop Stearns, Inc., New York, New York.

urine collected from forty-five to sixty minutes after the 60 cc. injection of hypaque would vary from 1.074 to 1.084. A 13 per cent hypaque solution has a specific gravity of 1.086 as determined with a calibrated office hydrometer at room temperature. If all the solutes in the urine were hypaque the 1.084 figure would represent about a 13 per cent solution. From Rapaport's work[9] on osmotic diuresis in hydropenic man it can be interpolated that the other solutes such as sodium, potassium, chlorides, phosphates and sulphate ions and urea would constitute about one tenth of this weight value. Thus, the actual hypaque concentration would be about 11.5 per cent or a 0.18 molar solution (molecular weight of hypaque—636). The resultant roentgenographic density in normal young adults who voided before the urography is so high, almost a zero absorption of light, that the bladder shadow on a late film would obscure filling defects that might be present (Fig. 1). Of course freezing point depressions for osmolarity and direct iodide determinations would help clarify the exact urine composition occurring during urography. Recent studies on tubular absorption of water (T^cH_2O and Tm^cH_2O) give further insight into the mechanism of this osmotic diuresis.

Fig. 1. Delayed cystogram in intravenous urography with hypaque, showing high roentgenographic density, which would obscure filling defects that might be present.

In 2 dehydrated young adults with normal renal function, the urine volume one half hour after the 60 cc. injection averaged 60 cc. with a specific gravity of 1.082, and the average the next half hour was 37 cc. with a specific gravity of 1.078. These data support a conclusion reached in a previous paper[4] that any further increase in the iodide load in a normal dehydrated subject would not, for practical purposes, increase the urinary concentration, except perhaps slightly in the second half hour collection period. An increase in the amount of iodide would only result in increased, but not proportionate, diuresis at the same high concentration. The maximum urinary concentration of all the various contrast iodides is limited to 0.18–0.22 molar solution.[4] Since the urinary concentration is limited, the roentgenographic density will only be increased by having larger molecules with a larger number of iodide atoms per molecule excreted by glomerular filtration. However, in patients not dehydrated or with poor renal function or hydronephrosis an increased load of an intravenous drug would result in increase in urine concentration but never to a maximum value. It is in these patients that the increase in iodide atoms per molecule would be of value.

The increased contrast of hypaque and urokon over diodrast and neo-iopax is due to the three iodine atoms instead of two per molecule, yet with equal molecular urine concentrations. A postulated decrease in plasma protein binding of urokon or hypaque as being most important in explaining the increase in contrast by causing an increased urine concentration is a fallacious concept in this instance.

Mechanism of Excretion

The amount of hypaque excreted by the tubules will have to be determined by true clearance studies with stable blood levels and with accurate plasma protein binding

studies. So far diodrast is the only contrast substance known to be excreted in large quantities by the renal tubules. After 60 cc. of 35 per cent diodrast was injected in a young dehydrated adult male, 100 cc. of urine was formed in one hour with a 9.0 per cent urinary diodrast concentration as deduced from the specific gravity (a total of 9.0 grams out of 21 grams in 60 minutes). Blood levels of over 40 mg. per cent are maintained after this dosage for one hour,[5] a level high enough to produce maximum tubular excretion for the entire sixty minutes. Since the Tm. of diodrast is 100 mg. per minute,[11] in the hour period 6.0 grams of diodrast are excreted by the tubules leaving 3.0 grams obtained by filtration. Josephson,[5] however, presents a chart (No. 4 which is incongruous with No. 2) in which these figures are reversed, with the greater amount excreted by filtration. These latter figures, if true, would indicate a definite depression of Tm. at these doses, similar to para-aminohippurate excretion in the cat.[3] Such a decrease in tubular excretion could be interpreted as due to reabsorption by lower tubules or depression of secretion because of the high concentration in the filtrate. Nevertheless, a considerable amount of diodrast is excreted by the tubules after 20 to 60 cc. despite one investigator's[8] misinterpretation of Josephson's work. It should be noted that at high blood levels obtained only in animal experiments slight miscalculations in the amount of protein binding will markedly affect the calculated tubular excretion. Errors in this determination cannot explain the variations in different investigations when the average levels in man (100 to 300 mg. per cent decreasing rapidly in a logarithmic curve) are obtained. For practical purposes the amount of tubular excretion has little significance, since urinary concentration is limited to a level easily reached with present doses. Even with damaged kidneys tubular excretion is probably unimportant with no differences in urinary concentration apparent between diodrast and the others. The lowered effective renal blood flow occurring with poor renal function is the most important factor limiting urine concentration. In 5 patients benemid, 1 gm., was given orally several hours before intravenous pyelography on the theory that it would block any tubular absorption of iodide that might be taking place. No particular increase in contrast could be demonstrated on these films.

Diodrast, mixtures of neo-iopax and diodrast, and urokon usually cause a decrease in the pH of the urine. Hypaque, on the other hand, produced a fairly marked increase in urinary pH, often to 6.5 or 7.0. With the mixtures or urokon, crystallization would occur when a highly concentrated urine stood at room temperature for five to fifteen minutes. These crystals dissolved on alkalizing or heating the urine.[4] No deposition of crystals occurred even with the higher urinary concentrations of hypaque, perhaps due to the elevation of the pH. This unusual change in urine acidity by hypaque could be due to a mild inhibition of renal carbonic anhydrase. It will be interesting to test this possibility especially since the chemical formula is different from diamox, a potent carbonic anhydrase inhibitor. Both chemicals have the CH_3CONH group but the active radical of diamox is stated to be the SO_2NH_2.[10] No proteinuria, such as occurs sometimes after urokon, resulted after intravenous pyelog raphy using hypaque.

In 5 patients with good renal function and no residual urine immediately after the 60 cc. of hypaque was injected, 6 mg. of phenolsulfonphthalein was also given intravenously. The forty-five to sixty minute urine collection showed only 10 to 15 per cent of the phenolsulfonphthalein instead of the usual 60 to 75 per cent. This could be interpreted to mean that a considerable amount of hypaque is excreted by the tubular mechanism in direct competition with the phenolsulfonphthalein. The quantity of hypaque, being much greater, depresses the tubular excretion of the phenolsulfonphthalein. However, the same 10 to 15 per cent phenolsulfonphthalein excretion in forty-five to sixty minutes occurred after the injection of 70 per cent urokon, yet only a small portion of urokon is excreted by the

tubules, at least in animals.[8] The small amount of urokon tubular excretion still could cause the depression, but some unknown osmotic competition in the tubules might account for the diminished phenolsulfonphthalein excretion. If this is true the depression should be able to be reproduced with an osmotic diuresis from some of the sugars.

In renal angiography, for a few seconds, a large quantity of contrast substance flows through the kidneys. If glomerular filtration continued at one-fifth of the effective renal plasma flow, a large quantity of iodide would be delivered to the tubules and the calyces. A review of aortograms fails to confirm this rapid appearance (the immediate nephrogram is due to vascular filling as is the splenogram and hepatogram). It is apparent that the large osmolarity of this mixture traversing the renal vessels is greater than the effective glomerular filtration pressure and therefore permits but little filtration. It is of interest that in the cat doses of 8,000 mg. of hypaque per kilogram caused a delay in appearance time with poorer visualization than at lower dosages.[6] With the distribution of iodide being mainly extracellular, the increased osmolarity of the plasma prevents filtration in these animals at this level of dosage. This osmolar factor plus the large loss of electrolytes that occurs with the diuresis would cause the death of the animals when 10,000 to 12,000 mg. per kilogram was injected. If the animals were hydrated and electrolytes replaced as soon as lost, the lethal dose in acute and chronic toxicity would be increased. The occasional tubular vacuoles seen in the kidneys after large injections may not indicate actual tubular damage but rather the osmotic effects described by Allen.[1]

Some investigators have claimed an increase in rate of excretion of one contrast substance compared to others, a factor that would be of economic importance.[2] However, no consideration of the molecular load was undertaken. Increasing the amount of the drug results in an increased diuresis and gives the appearance of a faster rate of excretion. Actually in this series and the previous one, when large molecular loads were utilized, the best density after the slow injection was obtained on the five to ten minute film, no matter which organic iodide was injected. Also, the same percentage of the dosage of diodrast, hypaque and urokon, 40 to 50 per cent, is excreted in the first hour at approximately the same osmolar concentration, when the 50 to 60 cc. amounts of the usual concentrations are used. This percentage, of course, will vary with the molecular load.[5]

TECHNIQUE OF UROGRAPHY

No matter which agent is used the most important factors in obtaining high density urograms are dehydration for sixteen to eighteen hours and the proper use of adequate compression. Previously other authors have recommended compression be used for ten to fifteen minutes,[12] but this is neither necessary nor desirable. A large balsa block (18×15×10 cm.) or rubber bag should be applied to the abdomen about five minutes after the intravenous injection with the patient in the Trendelenburg position. The compression is applied slowly gaining the confidence of the patient until the maximum of about 100 to 120 mm. of mercury is reached. This pressure is then maintained for only two minutes and the roentgenogram then taken with the block in place. It is most important to tighten this band every few seconds since any one of the respiratory movements may loosen it suddenly and result in a loss of urine iodide from the pelves and calyces. With this technique an actual dilatation of the calyces, pelves and upper ureters is seen to take place. On removing the compression to fill the lower ureters, the calyces and pelves contract within a few seconds and frequently on a two to three second exposure a double contour is produced (Fig. 2). Later films are then taken without compression in order to determine whether an actual hydronephrosis exists. Occasionally the collecting tubules in the papillae are outlined with this method of blocking the ureters. In general a greater distention of the calyces

Fig. 2. On removing the compression to fill the lower ureters, the calyces and pelvis contract within a few seconds and frequently, on a two to three second exposure, a double contour is produced.

and pelves, especially on the right side, is produced in women as compared with men, probably as a result of increased distensibility following the hydronephrosis of pregnancy.

When the compression device is applied to the lower abdomen of a moderately obese patient, a raised fat layer is produced directly over the renal area. The roentgen-rays thus have to traverse an increased amount of tissue with a resultant increase in secondary radiation and thereby a loss in roentgenographic detail. To overcome this difficulty the compression device can be applied to the upper abdomen and still produce blockage of the ureters, although at a higher level above the iliac crest. Another method is to apply the compression to the lower abdomen, but take the film within five seconds after release of the compression device. Taking the film in this way, it is necessary to use short exposures of two to four tenths seconds to avoid blurring of the calyces and pelves from motion. Even with the block in place during the taking of the roentgenogram, calyceal contractures occur in about one in every four films with a resultant slight blurring unless a short exposure is made. Only two minutes are necessary for the compression since an additional 3 cc. of urine is produced in this period by each kidney, enough for adequate filling. With longer compression there is no increase in distention but only loss of urine past the blockage point, yet, with an increased chance for an accidental let up of the compression by respiration or movement.

If the balsa block is placed more to one side of the mid or upper abdomen, then the kidney on that side will be filled to a greater degree. This demonstrates that the abdomen does not act as a completely fluid compartment and does not exactly follow Pascal's law of physics. Clinically, one may take advantage of this fact by deliberately applying during one exposure the block more on one side, often on the side of the kidney with no pathology, since the condition of this kidney will greatly influence any contemplated operative procedure. Incidentally, compression can be applied with the patient in an upright position and still cause partial obstruction of the ureter provided that proper supports are maintained so that the patient can relax his abdominal muscles. During the two minutes of compression the effective renal blood flow and glomerular filtration are decreased on an average of about 25 per cent but from a practical point this is not important. At any rate it is probably only a temporary decrease and not maintained if the compression were continued for many hours. No proteinuria was produced in this series using the compression for only two minutes except in a few instances with urokon; however, if compression were used for a much longer period occasional proteinuria might occur. Ordinarily the compression would produce a decrease in urine outflow but this must be a small change with an osmotic diuresis. I believe that recent evidence,

when using bilateral thigh compression and changing the position from supine to standing in order to produce the same decrease in renal blood flow, glomerular filtration and urine output, indicates that a decreased venous return to the heart with a subsequent decreased cardiac output is the basic physiologic process involved. The increased venous pressure on the valveless vena cava transmitted directly to the renal veins and the partial blockage of the ureters are only incidental factors in the resultant decreases of renal blood flow when using abdominal compression.

The use of adequate compression explains why 30 cc. produced contrast or density almost as good as 60 cc. of the 50 per cent hypaque except in patients not dehydrated or with poor renal function. The 30 cc. will maintain maximum urine concentration for a period of about fifteen minutes, enough to obtain excellent films. The 60 cc. will prolong the maximum elevation of the concentration in the urine and produce an increase in diuresis, but in general the actual contrast with the use of compression will not be much greater. However, if only 15 cc. of 50 per cent hypaque were used the maximum urine concentration would be obtained for only a few minutes, together with less diuresis, and the film would often not be taken at the exact time, resulting in less contrast. This same reasoning explains why 30 per cent urokon (25 cc.) was not adequate but 25 cc. of 50 per cent urokon and 70 per cent urokon gave denser shadows.

A method to obtain clearer renal outlines during intravenous pyelography is the use of a low kilovoltage technique with an increase in contrast because of the short scale contrast that is produced. For most other roentgen-ray work an increase in contrast is not desirable, but during intravenous pyelography one film taken with such technique may be of great help. This technique, when used carefully because of the decrease in latitude, is especially helpful to clarify faint stone shadows. One disadvantage of low kilovoltage is the tendency to obscure pelvic or ureteral filling defects, but other films taken with the usual settings or special studies with air contrast void this objection. Conversely, high kilovoltage technique with 16 to 1 grid ratios would be of no particular aid in routine urologic diagnosis except in delineating filling defects.

In conclusion, the preparation for intravenous pyelography should be tailored to the patient with immediate wet readings, spot roentgenograms, different postionings, delayed films and post-voiding films, in order to increase the value of this procedure. In the majority of patients and even in some of those with diminished renal function, films are obtained which eliminate the necessity of performing retrograde pyelography. The intravenous urograms provide more functional information than retrograde urograms and sometimes more structural data on the renal outlines because of the faint nephrogram. Nevertheless, retrograde pyelography will have to be performed when doubt exists or structural pathology is present. The value of intravenous pyelography, properly performed, is that retrograde pyelography on normal kidneys may often be eliminated. Figure 3 illustrates the type of renal filling that frequently can be obtained. The sharp blockage of the redundant ureters with actual kinking that was not present without compression can be seen. It is not uncommon to visualize, with the block in place, peristaltic waves of the ureters. Figure 4 demon-

Fig. 3. This illustrates the type of renal filling that frequently can be obtained in intravenous urography with hypaque. The sharp blockage of the redundant ureters with actual kinking, which was not present without compression, can be seen.

FIG. 4. This demonstrates that density with hypaque is great enough to obtain good urograms in oblique views, even the filled ureters being readily visualized, provided proper compression is used.

strates that density is great enough to obtain good oblique views even with the filling of the ureters readily visualized. Sometimes density is too great, but this objection can be eliminated by taking another film ten to fifteen minutes later with the balsa block.

SUMMARY

Fifty per cent hypaque has proved to be an excellent, almost ideal, urographic substance with minimal side reactions, and yet with roentgenographic densities equal to urokon, when equivalent molecular loads are utilized. No arm pain occurred with slow injections. No proteinuria or crystalluria resulted even after the 60 cc. dosage.

The urine concentration of all organic iodides is limited by diuresis to a 0.2 molar concentration no matter how great the molecular load. Hypaque results in an increased pH of the urine in contrast to other organic iodides perhaps due to the inhibition of renal carbonic anhydrase. Some of the osmotic relationships in excretion are discussed.

The most important factor in obtaining excellent urograms is the proper use of adequate compression for two minutes. Most technicians do not understand the factors involved so that poor filling is obtained, leading in most hospitals to discontinuance of this valuable procedure. The physician in charge must take an active interest in teaching the correct intravenous pyelographic procedure to technicians.

2621 Biscayne Boulevard
Miami, Florida

REFERENCES

1. ALLEN, A. C. The Kidney: Medical and Surgical Diseases. Grune & Stratton, New York, 1951, Chap. 7.
2. BARRY, C. N., and ROSE, D. K. Urokon sodium 70 per cent in excretory urography. *J. Urol.*, 1953, *69*, 849–855.
3. EGGLETON, M. G., and HABIB, Y. A. Excretion of para-aminohippurate by kidney of cat. *J. Physiol.*, 1950, *110*, 458–467.
4. HARROW, B. R. Intravenous urography using mixtures of radiopaque substances. *Radiology*, 1955, *65*, 265–270.
5. JOSEPHSON, B. Mechanism of excretion of renal contrast substances. *Acta radiol.*, 1952, *38*, 299–306.
6. LARSON, A. A., HOPPE, J. O., GRANT, J. I., and COULSTON, F. Data in the files of the Sterling-Winthrop Research Institute.
7. MOORE, T., and MAYER, R. Hypaque: Improved medium for excretory urography; preliminary report of 210 cases., *South, M. J.*, 1955, *48*, 135–141.
8. PORPORIS, A. A., ELLIOTT, G. V., FISCHER, G. L. and MUELLER, C. B. Mechanism of urokon excretion. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1954, *72*, 995–1003.
9. RAPAPORT, S. BRODSKY, W. A., WEST, C. D., and MACKLER, B. Urinary flow and excretion of excretion of solutes during osmotic diuresis in hydropenic man. *Am. J. Physiol.*, 1949, *156*, 433–442.
10. RUSKIN, A. Acetazolemide (Diamox) diuresis. *Arch. Int. Med.*, 1955, *95*, 24–32.
11. SMITH, H. The Kidney: Structure and Function in Health and Disease. Oxford University Press, New York, 1951.
12. ZATSKIN, H. R. Effective compression in excretory pyelography. *Radiology*, 1948, *50*, 639–644.

VOL. 75, NO. 5

ROENTGENOGRAPHIC BEHAVIOR OF THE URETER

By HUNTER B. FRISCHKORN, JR., M.D.
RICHMOND, VIRGINIA

THE ureter is a separate organ with a specific function. Its purpose is to receive urine from the kidney and by the pumping effect of peristalsis to convey the urine to the bladder. Consideration of the ureter as a distinct organ with a definite purpose results in added interest to the routine urogram and is of particular advantage to the observer. Physiologically and embryologically, the ureter, the renal pelvis and the calyces can be considered as one organ. The earliest rudiment of the ureter is a bud that forms on the dorsal side of the mesonephric or wolffian duct close to its entrance to the cloaca. It is first manifest in the 5 mm. embryo (five weeks) and grows cephalad, enlarging at its tip to form the renal pelvis and then, by budding, to form the renal calyces. It reaches its normal adult relation opposite the second lumbar vertebra in approximately nine weeks (30 mm. embryo).

The calyces normally number from seven to twelve, which in turn unite to form two or three major calyces, terminating in the renal pelvis. The ureter proper is continuous with the funnel portion of the renal pelvis and extends caudad to the bladder. Structurally, it is composed of three layers, the fibrous, the muscular, and the mucous coats. The fibrous coat (tunica adventitia) is continuous with the fibrous tunica of the kidney and the fibrous structure of the bladder. In the renal pelvis and renal calyces the muscular coat (tunica muscularis) consists of layers of circular and longitudinal fibers, the latter being lost at the margins of the papillae, with the circular fibers extending into the surrounding medullary substance. In the ureter proper, the muscular coat is very distinct, being composed of external longitudinal fibers, the middle layer of circular fibers with a less distinct internal layer of fibers in a longitudinal direction. The mucous coat (tunica mucosa) is a smooth layer of transitional epithelium, presenting longitudinal folds which are effaced by distention. The mucous and muscular coats are separated by a dense layer of fibrous tissue containing many elastic fibers.

The nerve supply of the ureter is complex. Intricate nerve plexuses from both the sympathetic and the parasympathetic are associated with the ureter. The ureter receives a nerve supply which is independent of the innervation of the kidney and the bladder. Wharton's work shows that nerves go directly to the ureter from (1) the lowest renal ganglia, and (2) the abdominal sympathetics (the aortic, hypogastric and pelvic plexuses). Wharton also describes an important connection between the upper end of the ureter and ganglia located just beneath the renal artery. Its possible significance, as will be mentioned later, might be correlated with some of the work of Andler. The blood supply of the ureter is from the branches of the renal, internal spermatic, hypogastric, and inferior vesical vessels.

The ureter proper is normally from 25 to 30 cm. in length. The abdominal segment begins at the ureteropelvic junction and courses parallel to the spine, being directed slightly medially when it crosses the pelvic brim at the bifurcation of the common iliac artery, where it becomes the pelvic segment. The pelvic segment curves relatively abruptly backward and outward, following the course of the true pelvis. It is most lateral where it crosses the obliterated hypogastric artery at the level of the ischial spine. By curving medially and anteriorly it then enters the bladder obliquely.

The ureter cannot be seen roentgenographically and only by catherization with a radiopaque catheter or by filling with a radiopaque substance can its course and contour be determined. The filled ureter is usually narrowed at three points: (1) at the ureteropelvic junction, (2) as it crosses the

pelvic brim, and (3) at its entrance into the bladder.

Peristalsis begins in the calycine system of the kidney. Morales, *et al.* cite, and it is universally known, that the calyces exhibit coordinated peristaltic activity. One of the best explanations of the peristaltic activity of the calyces has been made by Narath, who demonstrated muscular tissue in the walls of the major and minor calyces. According to his hypothesis, the collecting phase is accompanied by a relaxation of the musculi levator fornicis and the sphincter fornicis assisted by the contraction of the upper part of the musculus longitudinalis calycis. When filling is complete, the emptying phase is accomplished by the relaxation of the muscular sphincter calicis and the contraction of the lower part of the musculus longitudinalis calicis, after which the sphincter fornicis closes. The levator fornicis then contracts as the upper part of the musculus longitudinalis relaxes to effect a pulling of the mucous membrane on the papillae to prevent regurgitation of the urine into the papillary ducts. If this deduction is correct, the varied roentgenographic changes of the calycine system are easily explained.

The renal pelvis having been so filled then discharges its contents into the upper ureter, which in turn, by coordinated peristaltic waves of approximately four to twelve per minute, passes it on the to bladder. Little need be said to describe the normal peristalsis of the ureter. It can best be pictured as inconstant spindle-like dilatation preceded and followed by smooth but pointed, constricted areas existing for the purpose of propulsion. It is not to be confused with the normal widening of the lumen of the abdominal and pelvic spindles, since the caliber of the ureter varies greatly within the range of normal. More important, as will be described later, is that peristalsis in the collecting system of the kidney can be so marked as to give a roentgenographic appearance of obliteration or distortion of part of the collecting system and ureter proper. Hence, multiple or serial films may be necessary to evaluate properly the findings.

The modus operandi of peristaltic waves propagating along the ureter has given rise to much discussion. As early as 1869, Engleman, having demonstrated ganglia to be present only in the adventitia layers of the ureter, concluded that peristalsis was purely of myogenic origin. Later, in 1925, Hryntschak also demonstrated the presence of ganglia only in the adventitia layers. Opposing the views of Engleman and Hryntschak were Satoni, Dogiel, Maier, and others who demonstrated ganglia in the submucosal and muscular layers of the ureter. From the description by Baker and Bozler, it appears that the smooth muscle cells of the ureter possess intracellular bridges or syncytium which act as a conductive mechanism fully capable of conducting impulses for normal ureteral peristalsis. According to Lapides, Morales and others, the only stimulus necessary for the initiation and maintenance of normal peristalsis is the presence of sufficient urine or fluid to promote by distention the peristalsis of the ureter.

Baker and others state that the ureter is supplied by both sympathetic and parasympathetic fibers, but that they are not indispensable for the normal function of the ureter, even though it is supposed that the sympathetics would inhibit and the parasympathetics would increase peristaltic activity. Lapides showed from very conclusive experiments, using a pharmacologic approach, that the intact human ureter is entirely independent of the central nervous system, including the autonomic system and all of its ganglia. Furthermore, Lapides concluded that peristalsis in the intact human ureter is not effected *directly* by the administration of tetraethylammonium chloride, procaine high spinal anesthesia, doryl, epinephrine, prostigmine, atropine, transetin, depropanex, calcium levulinate, nitroglycerine, amyl nitrite, papaverine, lipolutin, pitressin, or avertin (intraureterally), benadryl, demerol and morphine. Lapides and others have shown,

however, that drugs may indirectly affect peristalsis by altering the urinary output and that within certain levels the peristaltic activity of the ureter is directly proportional to the amount of urine excreted. Thus, this excellent study of Lapides certainly shows convincingly that abnormal and unusual urographic changes in the ureter cannot be explained by the type of anesthesia or medication administered. Morales, *et al.* state that osmotic diuresis can be followed by urine flowing in a steady stream through the ureter without peristaltic activity. Lapides asserts that the nerve supply to the ureter contains only vasomotor and pain-conducting fibers.

The Effect of the Peristalsis and Tone of the Ureter by Denervation. Wharton states that from the physiologic point of view we may conclude on the basis of clinical observation that cutting of the ureteral nerves, as done in ureteral denervation, does not interfere with the motor function of the ureter and does not cause atony. Dodson points out that complete division of the nerves of the ureter will relieve ureteral pain without disturbing ureteral peristalsis or tone. However, mention is made by both Dodson and Wharton that ureteral peristalsis has been temporarily abolished by denervation of the renal artery and vein but not of the renal artery alone. Hess and Crabtree state that there is a possibility of temporary diuresis following sympathectomy of the renal pedicle, but there is no permanent alteration noted in the postoperative urograms. Andler has reported that denervation of the renal vein is followed by immediate increase in peristaltic activity of the ureter, only to result later in acute dilatation. In the operation on humans, total renal vein denervation is usually not attempted, and total denervation of the renal artery is not possible because of the location of the nerve fibers in the walls of the vessel. Andler asserts, as does Dodson, that complete denervation can cause atony, hydroureter and hydronephrosis, and claims that fibers pass from the renal pedicle and not to the ureter directly. Because of the possibility of denervation of the renal artery and vein secondarily affecting the ureter, it might be well to bear this in mind in evaluating ureteral atony resulting from renal denervation but not ureteral denervation.

Changes in Ureteral Activity Resulting from Obstruction. It would be extremely difficult, if not impossible, to obtain accurate data from normal human subjects as to the immediate and latent effects on peristaltic activity from obstruction. Using an anesthetized dog, Baker and Huffer with electromyographic methods found that incomplete or complete ureteral obstruction artificially produced was followed by an increase in force as well as rate of peristalsis in the normal ureter, but in five to ten minutes the rate and violence began to decrease. In thirty minutes both the rate and activity had decreased less than in the preclamping period. Changes secondary to obstruction in the dilated ureter, however, were not followed by an increase in the rate of peristalsis, but merely an increase in the amplitude of the tracing. Whether their findings can be practically correlated with the usual urogram is questionable. On the other hand, it seems well to remember its possibility in interpreting urograms when it is likely that a catheter has caused obstruction or, as in the case of excretory urograms, when artificial pressure is applied to the abdomen to effect compression of the ureter.

Effect of Stimulation on Ureteral Activity. Baker and Huffer state that stimulation of the ureter is followed by peristaltic waves that travel in both directions from the point of stimulation. It can, therefore, be expected that abnormal peristalsis exists in a ureter so stimulated by a stone or by instrumentation. The latter has been a common observation.

Ureteral Activity Following Surgery (Transected and Transplanted Ureters). Baker and Huffer studied normal ureters in dogs following transection and transplantation. No significant changes in the electromyogram were noted in transected ureters and ureters

anastomosed to the intestine or re-anastomosed into the bladder, unless stricture and dilatation developed as an operative complication. Therefore, in humans the urographic appearance of the ureter, as far as peristalsis and degree of dilatation are concerned, can be expected to remain normal unless dilatation or infection follows the operative procedure. Creevy, in a report of ureteral surgery, concludes that the ureter can be cut and re-anastomosed without deleterious effect as long as the ganglia remain intact. Turner, *et al.* cite that dilatation is the outstanding pathologic change in the transplated ureter and consider infection present in every case. Ureters transected or operated upon for the removal of stones will not be expected to show alteration in the peristaltic activity unless the muscle continuity is permanently damaged.

The Effect of Infection on Ureteral Activity. According to Hutter, peristalsis is increased as the result of pyelitis and, therefore, we may conclude that it may cause variation in the appearance of ureteral peristalsis noted on pyelograms.

Regurgitation and Antiperistalsis. Regurgitation or ureterovesical reflux is defined as an unimpeded backflow of contrast medium from the bladder into one or both ureters. The etiology and mechanics of this condition are not well understood. There has been disagreement among the writers as to whether reflux occurs in the normal individual, although it is now generally accepted as being a definite pathologic phenomenon. Reflux is sometimes encountered in the apparently normal individual during the act of voiding and has been reported often in children under general anesthesia. It is not supposed to occur in the dead subject, thus suggesting that the flaccid ureterovesical valve closes to act as a check valve against reflux. Graves and Davidoff conducted rather extensive experiments in animals, and concluded that regurgitation occurs in a normal ureter but that adequate bladder tone must be maintained in order for this phenomenon to arise. The same authors believe that there is probably never antiperistalsis. From the studies of Bozler, and as described by Baker and Huffer and from routine urographic examinations, it is thought that antiperistalsis can and does occur in apparently normal individuals, due to stimulation of the ureter by ureteral catheterization. Gruber believes from studies based on excision of the ureterovesical valve that there are antiperistaltic contractions as well as antiperistalsis in the hydroureter.

Regurgitation is commonly observed in infravesical obstruction and is sometimes seen in children without obstruction to the bladder neck. Surgical injury to the ureter at the ureterovesical valve, such as ureteral meatotomy can result in reflux. The presence or absence of regurgitation following anastomosis of the ureter into the bladder is an evaluation of the surgical accomplishment. Prather reports a case of vesicoureteral reflux cured by operation. Talbot and Bunts report 16 cases of ureterovesical reflux in 331 paraplegics. Bors and Comarr observed reflux in 23 per cent of paraplegics and thought it to be more common in those with cervical and thoracic lesions. Some cases of reflux have been attributed to congenital atony, a neurogenic dysfunction. In any of the above conditions reflux may be present in one or both ureters.

Large Ureters and Hydro-ureters. It is not the purpose of this paper to discuss the dilated ureter secondary to mechanical obstruction, and mention will be made only of some of the more common causes. They are ureteral stones, stricture, tumors, ureterocele and vesical tumors and kinking of the juxtavesical ureter. The term megaloureter, first mentioned by Caulk in 1923, is used to designate the hydro-ureter without evidence of mechanical obstruction. Relatively few cases without hydronephrosis have been reported. Saintu in 1896 reported dilated ureters in a seven and one-half month old fetus with relaxed and atonic ureteral orifices and without evidence of obstruction. Morris described a case of saccular dilatation of the ureter. Papin and Legueu in 1912 reported 4 cases

similar to those of Saintu. Idiopathic segmental dilatation of the ureter was reported by Lazarus and Ricci. Embryologic studies of the ureter by Gerard and Loraine showed that in the fetus the ureter is enormously dilated up until about four to five months. Persistence of the dilated state has been suggested as a possible cause for megalo-ureter. Muscle fibers, however, have been found in the ureter as early as three months, and Campbell found muscle fibers present in several cases, thereby concluding that the arrested muscular development would not explain the cause for this anomaly. Caulk and others reported the peristence of peristalsis after protracted dilatation. Neurogenesis and spinal cord disease seem remote as a possible cause of megalo-ureter, since this condition as already mentioned may be either unilateral or bilateral. If the hypothesis of Lapides is true, and it is very convincing, the absence of nerve connection due to spinal cord lesions would not cause segmented dilatation of the normal ureter.

Dilatation of the ureter and renal pelvis is so frequently associated with pregnancy that it has been considered "physiological." Schloss, *et al.* state the activity and tone of the ureters are decreased. Traut and others suggested that the etiology of this condition in the presence of pregnancy was hormonal or chemical and that it reached its peak during the eighth month. Lapides did not observe any change subsequent to the administration of lipolutin in the normal ureter. Whether artificially administered hormones and the hormones during pregnancy can be considered parallel is controversial.

The Small-caliber Ureter. The range of the normal is so great that wide variations in caliber of the ureter may exist without being pathologic. Abnormally small ureters do exist, however, as evidenced by difficulty in catheterization and the appearance of the opaque medium in the ureter filled either by the retrograde or by the excretory methods. Double ureters are usually of much smaller caliber when visualized by urographic methods, and in the multiple ureter peristalsis is almost universally lacking. Possibly decreased diuresis from the individual renal segments may result in insufficient quantity of urine to stimulate active peristalsis.

Changes in the Urographic Appearance of the Ureter Following Those Which May Simulate Abnormal Ureteral Activity. Nontuberculous pyelitis has been mentioned already as a cause for increased ureteral activity. Likewise, structural changes secondary to inflammation can simulate abnormal ureteral peristalsis. The classical changes secondary to pyelitis in the collecting system are readily recognized and need no further mention. However, in the ureter proper, dilatation and constriction as the result of inflammation are erroneously considered as abnormal ureteral activity. The changes secondary to tuberculosis are usually more evident than nontuberculous ureteritis and are the result of loss of elasticity of the ureteral wall and cicatrization. When the disease is advanced, the walls of the ureter may be rigid, producing shortening and irregular "beaded" appearance. Somewhat similar to those of tuberculosis are the changes produced by brucellosis and bilharzial periureteritis. Ureteritis cystica is considered a result of chronic infection. It is urographically characteristic, in that the filling defect in the contrast-filled ureter is that of numerous smooth, rounded negative shadows that may at times resemble multiple air bubbles. Fisher and Howard reported a peculiar wavy appearance of the upper third of each ureter associated with periarteritis nodosa in a young girl. Primary amyloidosis of the upper ureter with replacement of the muscle of the ureter has been reported by Gilbert and MacDonald as producing encroachment on the lumen with decreased ureteral activity. Tumors of the ureter alter the contour and characteristics in such a way as to simulate abnormal ureteral activity. The epithelial malignant tumors are more common, but hemangiomas and ureteral polyps do occur.

Intussusception of the ureter associated with a benign polyp was reported by Morley, *et al.*

SUMMARY AND CONCLUSIONS

The varied urographic appearance of the activity of the normal and abnormal ureter is interesting. Peristaltic activity is urographically present in the calyces, pelvis and ureter proper. Single film urograms may not demonstrate the true nature of ureteral activity, and multiple or serial exposures may be necessary for proper evaluation. The functioning ureter is in constant movement, and short exposures are preferred. The normally functioning ureter can be expected to empty the upper urinary tract in from seven to ten minutes when filling is by the retrograde method. This is the most accurate single criterion regarding ureteral function which can be demonstrated urographically. However, in excretory urograms, delayed function without evidence of obstruction renders this measure valueless. Trauma resulting from catheterization and stimulation by injection may cause abnormal ureteral activity, or may result in temporary cessation of peristalsis. Drugs and anesthesia do not affect ureteral activity directly, but only as they effect diuresis. However, certain drugs, such as depropanex and calcium gluconate, as evaluated clinically do seem to alter ureteral activity. Infection can increase urographic evidence of activity. Certain diseases produce changes simulating abnormal peristalsis. Immediate obstruction is accompanied by an increase in the rate of peristalsis as well as an increase in the amplitude of the peristaltic wave plus increased activity. These changes, however, are only temporary, and peristalsis quickly returns to approximately normal level. The etiology of megalo-ureter has no single explanation. Denervation of the ureter does not interfere with normal peristalsis and does not cause ureteral atony, whereas denervation of the renal artery and vein might produce secondary changes in the ureter. The normal ureter proper is an autonomous organ capable of normal function, even when deprived of its nerve supply. The only stimulus necessary for the initiation and maintenance of normal peristalsis is distention or stretching of muscle fibers. Antiperistalsis probably never occurs in the normal. The etiology and mechanics of regurgitation are not well understood, and even though it is sometimes encountered in the apparently normal, it is now generally conceded to be an abnormal phenomenon. Lack of coordination between the muscular activity of the ureter and that of the bladder is suggested as a possible cause of backflow. The presence or absence of backflow during ureterovesical anastomosis is an index of the operative success. Transected ureters anastomosed to the intestine or bladder exhibit normal activity, unless a stricture with subsequent dilatation or infection occurs.

1000 W. Franklin Street
Richmond 20, Virginia

REFERENCES

1. Andler, R. Atony of ureter with dilatation and hydronephrosis; their clinical occurrence and experimental production in animals. *Ztschr. f. urol. Chir.*, 1925, *17*, 298–357.
2. Baker, R., and Huffer, J. Electromyography in normal, transected and transplanted ureter. *Am. J. Physiol.*, 1953, *175*, 381–390.
3. Bors, E., and Comarr, A. E. Vesico ureteral reflux in paraplegic patients. *J. Urol.*, 1952, *68*, 691–698.
4. Bozler, E. Electric stimulation and conduction of excitation in smooth muscle. *Am. J. Physiol.*, 1938, *122*, 614–623.
5. Bozler, E. Action potentials of visceral smooth muscle. *Am. J. Physiol.*, 1938, *124*, 502–510.
6. Bozler, E. Electrophysiological studies on motility of gastrointestinal tract. *Am. J. Physiol.*, 1939, *127*, 301–307.
7. Caldwell, J. M., Jr., Marx, H., and Rowntree, L. G. Renal function after bilateral denervation of kidney in normal dogs. *J. Urol.*, 1931, *25*, 351–366.
8. Campbell, E. W. Megalo-ureter. *J. Urol.*, 1948, *60*, 31–45.
9. Caulk, J. R. Megaloureter: Importance of uretero-vesical valve. *J. Urol.*, 1923, *9*, 315–330.
10. Crabtree, E. G. Renal pedicle sympathectomy. *J. Urol.*, 1948, *59*, 748–762.
11. Creevy, C. D. Recognition and surgical cor-

rection of retrocaval ureter. *J. Urol.*, 1948, *60*, 26–30.
12. Dodson, A. I. Urological Surgery. Second edition. C. V. Mosby Company, St. Louis, Missouri, 1950.
13. Dogiel, A. *Arch. Mid. Anat.*, 1878, *15*, 66.
14. Engleman, T. W. *Arch. f. d. gen. Physiol.*, 1869, *2*, 243.
15. Fisher, R., and Howard, H. H. Unusual ureterograms in case of periarteritis nodosa. *J. Urol.*, 1948, *60*, 398–404.
16. Gerard, M. Thése de Paris.
17. Gilbert, L. W., and McDonald, J. R. Primary amyloidosis of renal pelvis and ureter; case report. *J. Urol.*, 1952, *68*, 137–139.
18. Graves, R. C., and Davidoff, L. M. Studies on ureter and bladder with especial reference to regurgitation of vesical contents. *J. Urol.*, 1923, *10*, 185–231.
19. Graves, R. C., and Davidoff, L. M. Studies on bladder and ureter with especial reference to regurgitation of vesical contents. *J. Urol.*, 1924, *12*, 93–103.
20. Graves, R. C., and Davidoff, L. M. Studies on bladder and ureters with special reference to regurgitation of vesical contents; regurgitation as observed in cats and dogs. *J. Urol.*, 1925, *14*, 1–17.
21. Gruber, C. M. Function of ureterovesical valve and experimental production of hydroureters without obstruction. *J. Urol.*, 1930, *23*, 161–179.
22. Hess, E. Renal sympathectomy; indications and limitations. *Urol. & Cutan. Rev.*, 1943, *47*, 395–399.
23. Hryntschak, T. Anatomy and physiology of nervous apparatus of bladder and ureter in man and in some mammals. *Ztschr. f. Urolog. Chir.*, 1925, *18*, 86–110.
24. Hutter, K. Füllungsanomalien und abnorme Peristaltik bei Pyelitis im Röntgenbild. *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, 1939, *59*, 316–328.
25. Lapides, J. Physiology of intact human ureter. *J. Urol.*, 1948, *59*, 501–537.
26. Lazarus, J. A., and Ricci, M. W. Idiopathic segmental ureteral ectasia in congenital solitary kidney. *J. Urol.*, 1953, *69*, 222–230.
27. Loraine, A. Thèse de Paris, 1921, 30.
28. Maier, P. *Virch Arch. f. Path. Anat.*, 1881, *88*, 49.
29. Morales, P. A., Crowder, C. H., Fishman, A. P., and Maxwell, M. H. Response of ureter and pelvis to changing urine flows. *J. Urol.*, 1952, *67*, 484–491.
30. Morley, H. V., Shumaker, E. J., and Gardner, L. W. Intussusception of ureter associated with benign polyp. *J. Urol.*, 1952, *67*, 266–271.
31. Morris, H. Surgical Disease of Kidney and Ureter. Vol. 2. Cassell and Company, Ltd., 1904.
32. Narath, P. A. Hydromechanics of calyx renalis. *J. Urol.*, 1940, *43*, 145–176.
33. Papin, E., and Legueu, F. *Arch. urol. de la chir. de Necker*, 1912, *1*, No. 4.
34. Prather, G. C. Vesico-ureteral reflux; report of case cured by operation. *J. Urol.*, 1944, *52*, 437–447.
35. Saintu, O. *J. Méd. de Paris*, 1896, *8*, 332.
36. Satoni, Y. *Am. J. Physiol.*, 1919, *49*, 474.
37. Schloss, W. A., and Solomkin, M. Acute hydronephrosis of pregnancy. *J. Urol.*, 1952, *68*, 885–892.
38. Talbot, H. S., and Bunts, R. C. Late renal changes in paraplegia; hydronephrosis due to vesico-ureteral reflux. *J. Urol.*, 1949, *61*, 870–882.
39. Traut, H. F., McLane, C. M., and Kuder, A. Physiological changes in ureter associated with pregnancy; relationship between atony and dilatation of tract. *Surg., Gynec. & Obst.*, 1937, *64*, 51–58.
40. Turner, G. G., and Saint, J. H. Intravenous pyelography in series of cases after transplantation of ureters. *Brit. J. Surg.*, 1936, *23*, 580–597.
41. Wharton, L. R. Innervation of ureter with respect to denervation. *J. Urol.*, 1932, *28*, 639–673.

CYSTOURETHROGRAPHY*

CLINICAL EXPERIENCE WITH THE NEWER CONTRAST MEDIA

By JOSEPH J. KAUFMAN, M.D.,† *and* MURRAY RUSSELL, M.D.‡

LOS ANGELES, CALIFORNIA

ALTHOUGH urethrography is not part of a routine urologic diagnosis, it nevertheless has proved its value in demonstrating to advantage lesions of the bladder neck, urethra and its adnexa. It is widely practiced among urologists and yet there is no standard medium being used.

The purpose of this paper is to describe the experience of the authors with two urethrographic media, namely urokon§ jelly and salpix‖ to re-emphasize the hazards associated with the use of oily substances in the urethra, and to stress the value of the voiding cystourethrogram.

The history of urethrography is interesting because of the variety of substances which have been used since its inception. Since Cunningham[5] first described the procedure in 1910 using 50 per cent argyrol, many different substances have been employed. These have included suspensions of barium, bismuth and thorium, solutions of potassium and sodium iodide, silver salts, iodized oils and water soluble organic iodides. The ideal substance for urethrography must be one which possesses good radiopacity, both for retrograde and voiding urethrograms; it must be sterilizable, inexpensive, nonirritating to the urethral mucosa, miscible with urine, sufficiently viscous to outline the urethra in detail, and harmless if introduced into the circulation.

Flocks[8] did much to popularize urethrocystography in 1933, when he reported his results using mixtures of lipiodol, neo-iopax or diodrast with gum tragacanth. The mixtures provided fairly viscous media with adequate radiodensity, but they have been criticized for several reasons. Lipiodol carries the risk of oil embolism, while the organic iodide-gum mixtures were felt by some to lack sufficient viscosity and stability.

Coe and Arthur,[3] Brodny and Robins,[2] and Richards[11] felt that they found the closest approximation to the ideal contrast medium for cystourethrography when they reported their results using visco-rayopake.* Subsequent experience proved this product to have an irritant action, however, and its manufacture was discontinued. Brodny[1] has recently employed a new substance, medopaque† which he considers superior to other preparations. However, no details concerning this material are currently available. With fatal embolism reported not only after the use of oily media in the urethra, but also following the use of barium and thorium, it must be conceded that the safest preparation will be one using compounds such as those employed for intravenous urography.

Cases of fatal oil embolism have appeared steadily in the literature and it is therefore surprising that oily media are still being used. In 1947 Crabtree[4] reviewed the literature and found 27 cases of urethrovascular invasion with 4 fatalities due to fat emboli occurring after the use of oily media in the urethra.

In 1951 Fernicola[6] reported his experience with the use of an oily medium, iodochlorol,‡ in 200 urethrograms. He

* Visco-Rayopake, Hoffman-La Roche, Inc., Nutley, New Jersey.

† Medopaque U, Bell-Craig Co., New York.

‡ Iodochlorol, Searle Laboratories, Chicago, Illinois.

* Read before the Thirty-first Annual Meeting of the Western Section of the American Urological Association, March 25, 1955, Coronado, California.

† From the Division of Urology, Veterans Administration Hospital and the University of California Medical Center, Los Angeles, California.

‡ From the Department of Urology, College of Medical Evangelists, Los Angeles, California.

§ Urokon, Mallinckrodt Chemical Works, St. Louis, Missouri.

‖ Salpix, Ortho Research Foundation, Raritan, New Jersey.

correlated various factors such as the effect of pressure of injection, vascularity, viscosity, quantity of contrast medium and the presence of urethral pathology in the production of extra-urethral and urethrovascular invasions. He found that urethral disease was a prerequisite for the production of extravasation. He condemned lipiodol for its production of pulmonary oil embolism while he condoned iodochlorol because, even though it had been demonstrated in the venous system, it had not been known to cause fatal embolism or non-fatal pulmonary embolism. He felt that the behavior in the blood of various oils such as peanut oil, cottonseed oil, and mineral oil is presumably different. The purpose of this paper is to take exception to the aforementioned statements, and to reaffirm the fact that *no oily substance injected into any part of the body is without hazard.*

Venous invasion is frequent when solutions are instilled into the diseased or traumatized urethra and hence, oil is particularly hazardous. Figure 1 illustrates the extent of venous invasion which can be produced in performing urethrography. In this case, pressure was used to overcome resistance from a stricture. A water soluble solution was employed. No untoward systemic effects were encountered. In another case where iodochlorol was used the outcome was disastrous.

Fig. 1. Extensive filling of the veins of the penis obtained by the injection of radiopaque substance in the urethra. Patient had urethral stricture and pressure syringe method was used.

REPORT OF CASE

H.S., a seventy-three year old white man, was admitted to Cedars of Lebanon Hospital on December 7, 1953, complaining of severe urinary frequency and diminishing force of the stream. In his past history there was evidence of cardiovascular disease, psychoneurosis with anxiety state, and a right inguinal hernia. Urologic examination revealed prostatic enlargement of moderate degree. On December 10, cystoscopy was attempted with a 20 McCarthy Foroblique panendoscope. A total obstruction in the prostatic urethra was met which could not be negotiated by instrument or coudé catheter. A urethrogram using 30 cc. of iodochlorol was made and this showed a dilatation of the bulbo-membranous urethra representing a diverticulum, with evidence of contrast material in the periurethral tissues and with urethrovascular invasion (Fig. 2).

Three days later, the patient saw his local physician because of weakness, dysuria and strangury. He was found to have a pulse rate of 104 with blood pressure of 80/60. On the assumption that he had a coronary occlusion, he was admitted to the hospital; there he was found to be comatose with no obtainable blood pressure. His pulse rate was 80, the heart tones were faint and Cheyne-Stokes respirations were present. There was no evidence of periurethral swelling, fluctuation or tenderness. Continuous intravenous levophed was given and seven hours after admission, the patient became conscious and passed small quantities of urine. However, from the fourteenth to the twenty-first of December he continued to be in a semi-comatose condition with circulatory collapse. Progressive azotemia accompanied by diminishing urinary putput occurred until his death on December 21, 1953.

At autopsy there was evidence of recent myocardial infarction. In addition, there was a 2.5 cm. diverticulum of the urethra just distal

FIG. 2. Iodochlorol urethrogram showing urethral diverticulum and periurethral extravasation of contrast medium.

to the triangular ligament. There was fat in the periurethral vascular spaces with lipogranulomatous reaction. Fat emboli were found in the brain, lung, heart and kidneys (Fig. 3).

It seems well established that the risks associated with the use of oily urethrographic media should exclude any such products from being used. However, even aside from this most important objection, the use of oily substances for urethrograms is attended by other disadvantages; heavy radiopaque oils often produce artefacts which make interpretation difficult. This is particularly true in the delineation of bladder and vesical neck pathology which cannot be demonstrated because the oil does not mix with urine and puddles in the dependent portion of the bladder. We feel that in the two media which we have used, we have found a close approximation to the ideal in regard to safety and roentgenographic quality.

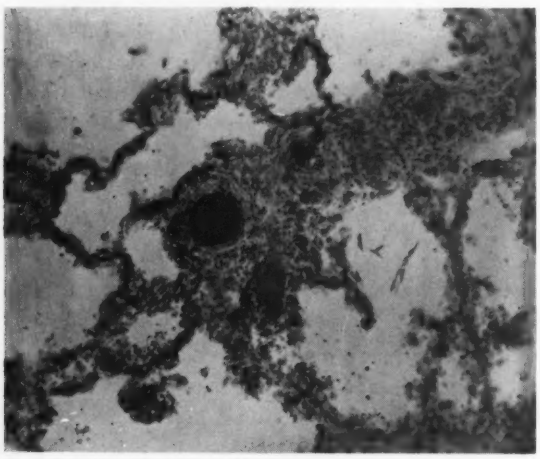


FIG. 3. Photomicrograph showing oil droplets in the lung. (Slide—courtesy of Department of Pathology, Cedars of Lebanon Hospital, Los Angeles.)

Urokon sodium 70 per cent was mixed with water soluble lubricating jelly (lubafax*) in equal parts. The solution can be drawn into a syringe easily and can be injected without difficulty. The mixture of urokon and water soluble jelly is a modification of the preparations first described by Flocks.[8] Urokon sodium 70 per cent has been shown to possess greater radiodensity than 75 per cent neo-iopax and 70 per cent diodrast and sensitivity reactions have been reported to be fewer than with either of the other two preparations.[10]

Recently, a thixotropic preparation containing urokon and incorporating qualities similar to those of urokon jelly has been produced commercially and has been named

* Lubafax, Burroughs-Wellcome, Tuckahoe, New York.

thixokon.§§ We have investigated this medium in performing over 75 urethrograms and have found that this preparation satisfies all the aforementioned criteria for a safe and satisfactory urethrographic medium.

There has not been sufficient stress placed on the use of the voiding cystourethrogram. This technique often demonstrates voiding dynamics and may illustrate pathology impossible to visualize with the injection method alone. Johanson[9] has used the voiding urethrogram to advantage in demonstrating prestenotic dilatation in the presence of urethral strictures. Fisher and Forsythe[7] have recently found the voiding cystourethrogram to be of value in evaluating enuresis.

The technique which we have employed is as follows: The patient is asked to retain urine for two to three hours before the examination. The Brodny clamp is used on all males. Thirty cc. of the medium is slowly injected with the patient recumbent and a film is taken in the anteroposterior position during the last phase of the injection. The patient is then positioned for the oblique projection and a film is taken just before the injection of an additional 30 cc. of medium is completed. The Brodny clamp is then removed and the patient is placed in the upright oblique position. He is asked to void into a disposable plastic bag attached to the penis and as soon as the stream has attained momentum, a third exposure is made.

We have found that the optimum exposures are made at 10 milliampere seconds and 100 kilovolts. This technique will obviate the "burning out" of the anterior urethra which is commonly seen when lower voltage, higher milliamperage and longer exposures are used. When equipment capable of obtaining this exposure is not available, such as is the case with standard urologic roentgen-ray apparatus, satisfactory roentgenograms can be achieved by using approximately 25 milliampere seconds and 70 to 75 kilovolts for the average patient. We have found that when urethrograms are done on patients who have retained urine in the bladder, the urokon jelly or salpix mixes readily with the urine and produces satisfactory urethrocystograms.

Figures 4 to 8 are urethrograms made with urokon jelly and demonstrate various pathologic conditions. Figure 4 illustrates a short stricture of the bulbous urethra on retrograde injection method (*a* and *b*) and in the voiding cystourethrogram (*c*). Figure 5 illustrates multiple strictures of the urethra following transurethral surgery; (*a*) and (*b*) are retrograde injection films and (*c*) demonstrates the prestenotic dilatations on voiding urethrography. Figure 6 shows the tremendous elongation and dilatation of the prostatic urethra in a patient with huge prostatic enlargement; (*c*) is the voiding cystourethrogram.

Figure 7 represents urethrograms which were done on a patient who had persistent urinary infection for four months after transurethral resection of the prostate. The voiding urethrogram (*c*) demonstrates filling of the bladder diverticulum during micturition. It also shows filling of a cavernous sinus in the prostate remnant which is not seen in the films obtained by the retrograde method (*a* and *b*). Figure 8 demonstrates extensive ulceration in a case of carcinoma of the urethra.

The urokon-lubafax medium was used in over 100 cases, and with the exception of occasional mild burning associated with its use, has shown no early or late toxic manifestations.

Salpix is a contrast medium composed of polyvinylpyrrolidone with sodium acettrizoate. The latter contains 65.8 per cent iodine per molecule and possesses a high degree of radiopacity. Polyvinylpyrrolidone, a plasma expander, provides viscosity and tissue adhesiveness to the medium. The compound is stable and water soluble, and varying density can be obtained from diluting with water. Its use was first reported by Rubin, Myller and Hartman[12] in 1953, for uterosalpingogra-

§§ Thixokon, Mallinckrodt Chemical Works, St. Louis, Missouri.

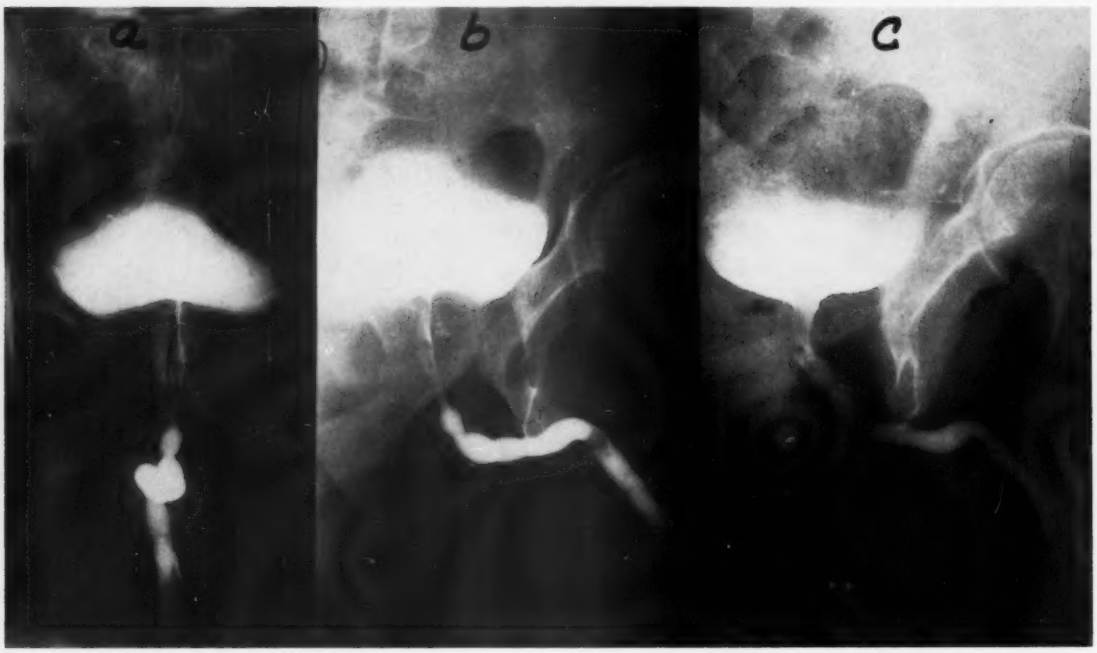


FIG. 4. (*a*) Urokon jelly urethrogram in a patient with postgonorrheal stricture of the bulbous urethra; *a* and *b* were obtained by retrograde injection and *c* is a voiding cystourethrogram.

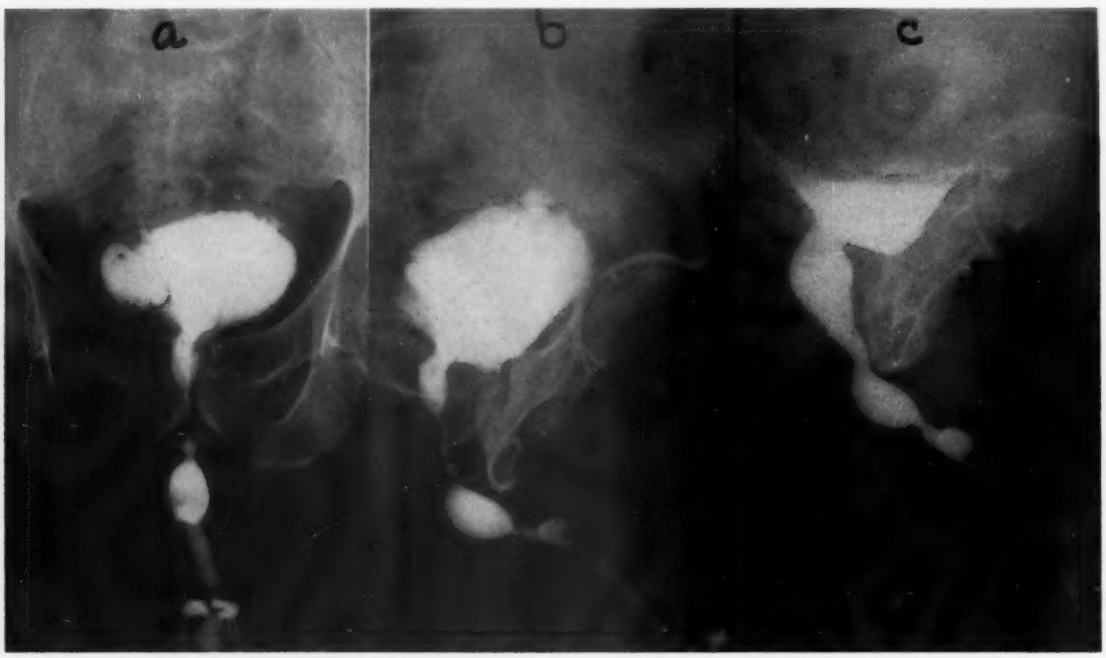


FIG. 5. Urokon jelly urethrograms in a patient with multiple postoperative urethral strictures; *a* and *b* obtained by injection, *c* is a voiding cystourethrogram.

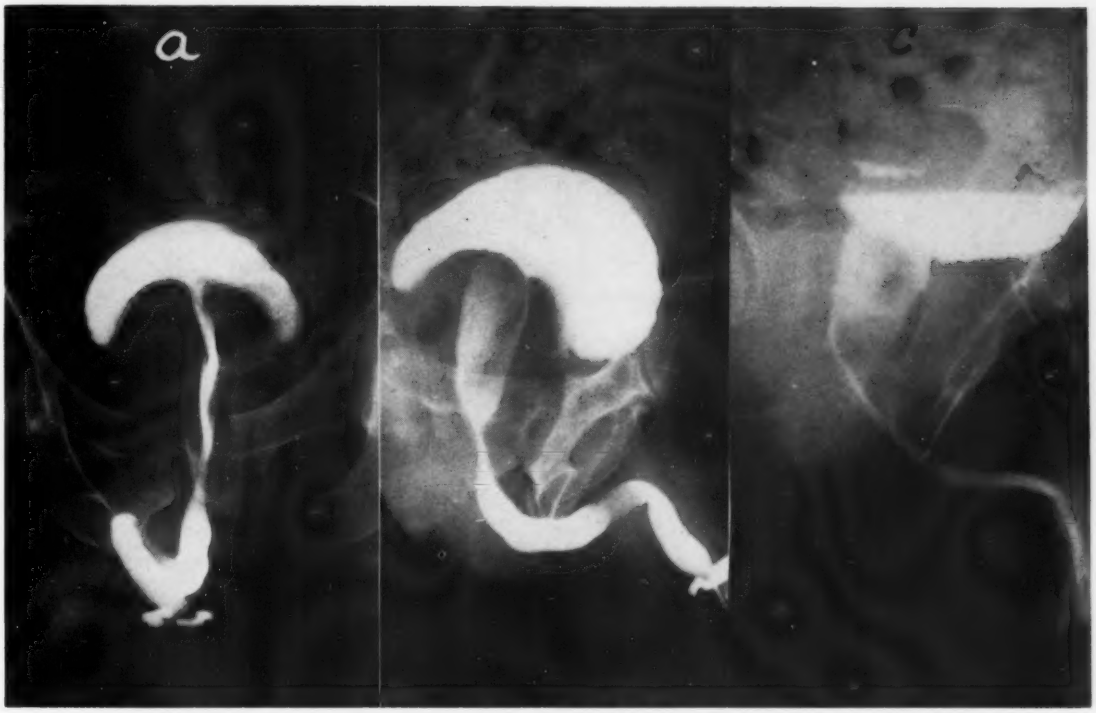


Fig. 6. Urokon jelly urethrograms in a patient with grade 3 prostatic hypertrophy; *a* and *b* were obtained by retrograde injection, *c* is a voiding cystourethrogram.

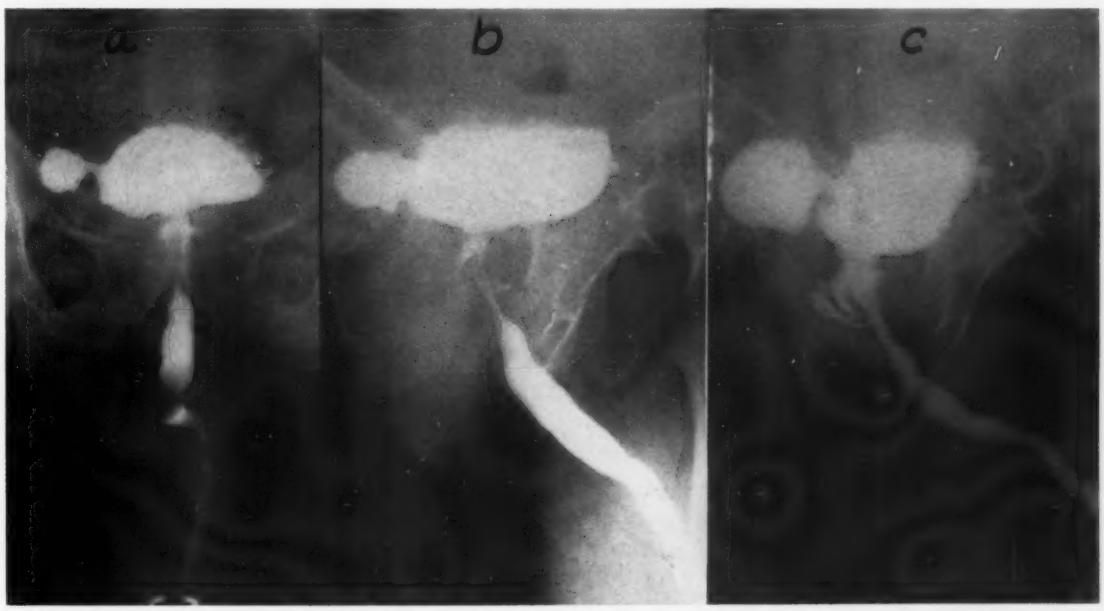


Fig. 7. Urokon jelly urethrogram in a patient four months following transurethral prostatectomy. Filling of bladder diverticulum and prostatic sinus is seen to advantage in voiding cystourethrogram (*c*).

FIG. 8. Urokon jelly urethrogram in a patient with extensive carcinoma of the bulbous urethra (retrograde injection only).

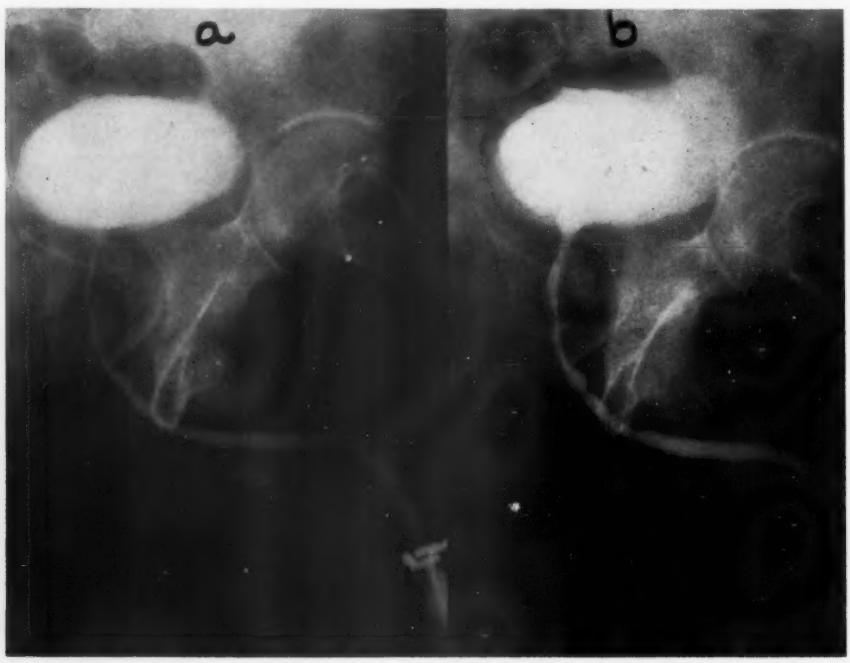


FIG. 9. (*a*) Salpix one to three and (*b*) urokon jelly urethrograms in the same patient and using similar roentgenographic technique. Comparative radiodensity is demonstrated.

phy. Experimental work was done by these investigators, who found that intravenous and subcutaneous injection of salpix in monkeys, rabbits and dogs produced no signs of irritation or toxicity.

The same technique was used in obtaining roentgenograms with salpix as has been described for urokon jelly. Excellent roentgenographic quality was achieved when salpix was used in concentrated solution and in dilutions up to one part salpix to three parts of water. However, further dilu-

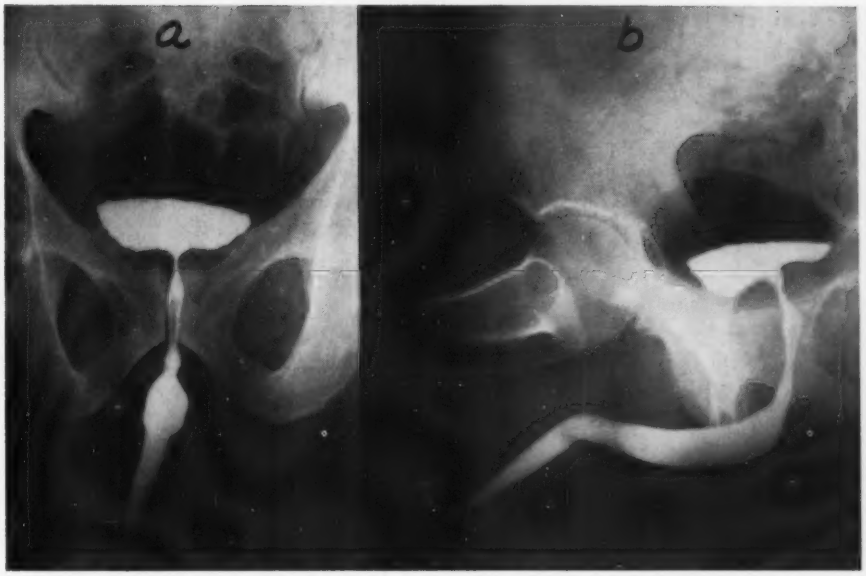


Fig. 10. Salpix concentrated. Normal urethrogram. *a* is anterior posterior view, *b* is oblique.

tion resulted in poor radiodensity for urethrographic use. In 25 cases studied, salpix was found to be nonirritating, nontoxic, and miscible with urine. One of its disadvantages is that unless heated, there is a tendency for crystals to form. Its cost in concentrated form and in low dilutions is excessive as compared with urokon jelly. Figure 9 illustrates the comparative density of salpix one to three (*a*), and urokon jelly (*b*), in the same patient and using identical roentgenographic technique. It is seen that both substances mix with urine to provide a satisfactory urethrogram; however, the urokon jelly is of greater radiodensity than salpix in one to three dilution. Excellent opacification by the contrast medium in its concentrated form is seen in figure 10 which is a normal cystourethrogram. Figure 11 demonstrates urethral diverticula in a female with gonorrheal urethritis and suburethral abscess. Undiluted salpix was used.

Fig. 11. Urethral diverticula in female with gonorrheal urethritis and suburethral abscess. Undiluted salpix was used.

CONCLUSIONS AND SUMMARY

No single radiopaque preparation for urethrography has obtained general acceptance by urologists. The use of oily substances in the urethra is condemned and a case report illustrating fatal oil embolism is presented. Two preparations, urokon jelly and salpix, have been evaluated as urethrographic media. Both are acceptable from the standpoint of miscibility with water and urine, absence of toxicity and significant irritation, and quality of roent-

genograms. Uroken jelly made by using one 25 cc. ampule of 70 per cent urokon and approximately one half of a 5 ounce tube of lubafax, was found to be superior because of the lower cost and ease of preparation. A commercially prepared mixture with properties similar to the urokon jelly (thixokon) may be available in the near future.

Voiding cystourethrograms provide a valuable addition to the diagnosis of vesicourethral pathology in a variety of conditions and deserve further exploitation.

Joseph J. Kaufman, M.D.
435 No. Roxbury Drive
Beverly Hills, California

REFERENCES

1. BRODNY, M. L. Urethrography: Its value in study of male fertility and sterility. *Fertil. & Steril.*, 1953, *4*, 386–411.
2. BRODNY, M. L., and ROBINS, S. A. Use of new viscous water-miscible contrast medium rayopake for cystourethrography. *J. Urol.*, 1947, *58*, 182–184.
3. COE, F. O., and ARTHUR, P. S. New medium for cystourethrography. AM. J. ROENTGENOL. & RAD. THERAPY, 1946, *56*, 361–365.
4. CRABTREE, E. G. Venous invasion due to urethrograms made with lipiodol. *J. Urol.*, 1947, *57*, 380–389.
5. CUNNINGHAM, J. H. Roentgen Rays. *Trans. Am. Assoc. Genito-Urin. Surg.*, 1910, 369–371.
6. FERNICOLA, A. R. Extra-urethral confines of urethrographic contrast medium. *J. Urol.*, 1951, *66*, 132–144.
7. FISHER, O. D., and FORSYTHE, W. I. Micturating cystourethrography in the investigation of enuresis. *Arch. Dis. Childhood*, 1954, *29*, 460–471.
8. FLOCKS, R. H. Roentgen visualization of posterior urethra. *J. Urol.*, 1933, *30*, 711–736.
9. JOHANSON, B. Reconstruction of male urethra in strictures. *Acta chir. scandinav., Suppl.*, 176, 1953.
10. MELICK, W. F., BYRNE, J. E., and BOLER, T. D. Experimental and clinical investigation of various media used in translumbar aortography. *J. Urol.*, 1952, *67*, 1019–1025.
11. RICHARDS, C. E. Visco-rayopake in cystourethrography. *J. Urol.*, 1947, *58*, 185–191.
12. RUBIN, I. C., MYLLER, E., and HARTMAN, C. G. Salpix: New approach to ideal radiopaque medium for hysterosalpingography. *Fertil. & Steril.*, 1953, *4*, 357–370.

Vol. 75, No. 5

POSITION OF THE PATIENT FOR ROENTGENOLOGIC INTERPRETATION OF PROSTATOGRAM

By A. ESTIN COMARR, M.D.*
LONG BEACH, CALIFORNIA

PROSTATOGRAMS have been found useful during routine cystourethrography in spinal cord injury patients. The technique of cystourethrography has been previously described.[5] Radiopaque material within the prostatic ducts will generally be visualized over the region of the symphysis pubis or just above.[1,2,3,7] Anatomic variations in the lumbosacral angle can cause the prostate to appear more superior to the symphysis pubis than is usual.[6] If the prostate is large (which does not pertain to spinal cord injuries) or if the roentgenogram has been exposed in such a manner that the prostatic area is projected above the level of the symphysis, the radiopaque material in the prostatic ducts may cast a shadow higher above the symphysis pubis than is normal[7] and could then create the impression of a seminal vesiculogram.

The importance of taking into consideration the position of the patient on the roentgenographic table when making a diagnosis is demonstrated in the following case report.

Routine cystourethrography was performed on a patient with a complete lower motor neuron syndrome at T-10. Figure 1 shows the resulting cystourethrogram taken with the patient in the supine position. The bilateral densities at the bladder base were found well above the pubic symphysis; because of this high position it remained equivocal whether these densities represented opacified prostatic ducts or seminal vesicles. Therefore, a seminal vesiculography via the vas deferens[4] was performed and was quickly followed by cystourethrography.[5] Figure 2 shows the resulting seminal vesiculogram. In Figure 3 with the patient in lithotomy position, the prostate is visualized directly over the pubic bone, and yet the lateral edge of the right seminal vesicle is sufficiently opacified to indicate that the seminal vesicles are overlaid by the contrast material in the bladder. Comparing the opacities below the bladder outline in Figure 1 with the contour of the prostate in Figure 3 proves unequivocally that these structures belong to the prostate and not to the seminal vesicles.

FIG. 1. Cystourethrogram made in the supine position showing opacified prostate that is partially under the bladder and above the pubic bone.

Figure 4 shows the faint outlines of both

* From the Paraplegia Service, Veterans Administration Hospital, Long Beach, California, and the School of Medicine, Department or Urology, College of Medical Evangelists, Los Angeles, California.

FIG. 2. Seminal vesiculogram performed by injection of contrast medium through the vas deferens.

the prostate and the more prominent seminal vesicles after removal of the contrast medium from the bladder.

FIG. 4. The contrast material has been drained from the bladder. The seminal vesicles are well shown whereas the prostate is seen very faintly.

SUMMARY

1. The opacified prostate may be found superior to or overlying the pubic bone depending on the position of the patient on the roentgenographic table.

2. Unequivocal differentiation is possible by a combination of seminal vesiculography

FIG. 3. Cystourethrogram superimposed over the seminal vesiculogram showing the opacified prostate over the pubic bone; a portion of the right seminal vesicle presents itself as well as the vas bilaterally. Patient in lithotomy position.

through the vas deferens and prostatography by means of cystourethrography in the lithotomy position.

Veterans Administration Hospital
Long Beach 4, California

Note: This paraplegic patient developed bilateral ischial decubitus. In order to perform an adequate closure of this decubitus, bilateral subperiosteal "ischialectomy" was performed. The films show the postoperative proliferation many months after removal of the ischial tuberosities and rami. The decubitus remained healed.

REFERENCES

1. Beard, D. E., Goodyear, W. E., and Weens, H. S. Radiologic Diagnosis of the Lower Urinary Tract. Charles C Thomas, Publisher, Springfield, Ill., 1952.
2. Braasch, W. F., and Emmett, J. L. Clinical Urography. W. B. Saunders Company, Philadelphia, 1951.
3. Colby, F. H. Essential Urology. Second edition. Williams & Wilkins Company, Baltimore, 1953.
4. Comarr, A. E., and Bors, E. Spermatocystography in patients with spinal cord injuries. *J. Urol.*, 1955, *73*, 172–178.
5. Comarr, A. E., and Dodenhoff, L. Safe, simple method of performing urethrograms. *J. Urol.*, 1953, *70*, 980–981.
6. Peha, J. Personal communication.
8. Wessen, M. B. Urologic Roentgenology. Third edition. Lea & Febiger, Philadelphia, 1950.

EXCRETORY PYELOGRAPHY IN INFANTS*

TECHNIQUE FOR INTRAVENOUS INJECTION

By EDWARD B. SINGLETON, M.D., *and* GUNYON H. HARRISON, M.D.

HOUSTON, TEXAS

THE problems encountered in obtaining excretory pyelograms of diagnostic quality in the young pediatric patient are familiar to urologists and radiologists alike and the methods devised to overcome these problems have been described sporadically in the medical literature. The frequent inability to obtain satisfactory visualization of the upper urinary tract of the infant results from the presence of gas in the small intestine, a normal finding in this age group, and from insufficient concentration of the contrast material in the collecting system of the kidneys.

The honey-combed pattern of gas in the intestinal tract of the infant makes its appearance a few hours after birth[10] and is a normal finding until the child is ambulatory. Even after this, especially if the child has been crying, an abundance of small bowel gas is a frequent finding.[8] The confusing pattern of gas and bowel wall overlying the renal areas greatly encumbers the accurate localization of the calyces even when the concentration is satisfactory. Preliminary enemas are of little value and often increase the amount of intestinal gas. Cathartics are also unsatisfactory in decreasing the amount of gas in this age group and actually may be harmful, particularly if the infant is acutely ill. Several excellent articles[1,2,4,6] have appeared advocating the use of carbonated beverages which distend the stomach, thereby displacing the small intestine and allowing the renal shadows to be clearly identified. This procedure not only enables a clearer more unobstructive view of the renal collecting system but pacifies the infant and reduces the chance of "motion" on the roentgenograms. In our experience the use of a carbonated beverage has largely overcome the problem of overlying intestinal gas.

Inadequate concentrating ability of the infantile kidney may be occasionally responsible for unsatisfactory pyelograms. Although the kidneys of the newborn infant do not have the concentrating capacity of the older child or adult, this ability is attained by the age of six months and probably earlier. And even though in the newborn infant the concentrating power has not completely developed, satisfactory pyelograms may still be obtained and one should not disregard the value of the procedure in the very young patient.

Another explanation for decreased concentration of the contrast material is the absence of preliminary dehydration. Although it is not wise to dehydrate a severely ill infant, moderate dehydration is not harmful and the withholding of only one feeding of the baby who is on a scheduled program is adequate for satisfactory dehydration.

Although the problems of intestinal gas and inadequate dehydration are complicating factors, the most common excuse on the part of the urologist and radiologist for avoiding the procedure is the difficulty in doing a venipuncture on an infant. And although some authors advocate intramuscular[5,9] or subcutaneous[7] injection, the possibility of severe local reaction is real and the excretion by the kidneys is less dependable than by the intravenous route.

In 1950 Gardner and Murphy[3] described a technique of administering intravenous fluids to infants. Their method consists of using a "short bevel" needle without the usual hub to which is attached a length of polyethylene tubing (Fig. 1). In this manner the needle can be securely taped against the skin and the difficulty of holding the syringe and needle in alignment with the vein of the struggling infant is obviated. By

* From the Departments of Radiology and Pediatrics, Texas Children's Hospital, Houston, Texas.

Fig. 1. (*A*) Petri dish containing zephiran chloride used to sterilize and store needle and polyethylene catheter. (*B*) Ten cc. syringe. (*C*) Short bevel, 1½ inch needle and attached polyethylene catheter. (*D*) Sterile saline. (*E*) Hemostat used to hold needle during injection.

using this method superficial veins may be more easily entered and the movement of the patient does not dislodge the needle. Since adapting this method for excretory pyelography we have successfully performed over 200 consecutive pyelograms in infants and young children without failing to introduce the contrast material into a vein. Although the needle and its attached catheter was originally devised for use on scalp veins, other superficial veins either in the hands, feet or even the external jugular, which is particularly prominent in most crying infants, serve as suitable and often more preferable sites for injection. Although this technique is widely used in administering intravenous infusions in infants, no reference to its application in excretory pyelography is found in the radiologic literature. Therefore, a description of its use in this regard is believed to be worthwhile.

TECHNIQUE

If the infant is on a scheduled feeding, the last bottle is withheld and the examination carried out after approximately six to seven hours abstinence from fluids. Although the amount of dehydration is negligible, it is enough to insure satisfactory concentration of the contrast material by the kidneys. The older infant has a longer period of dehydration, receiving nothing after the evening meal preceding the pyelographic examination the next morning.

A preliminary scout film of the abdomen is obtained and the infant is then inspected for a suitable vein. The most prominent veins are usually found in the scalp, hands and wrists, and feet. If the injection is made in one of the scalp veins, it is usually necessary to shave this area in order that the needle may be immobilized by adhesive tape. If the foot or hand is the site of injection, the extremity is immobilized by a

FIG. 2. Technique of injecting superficial vein. After the vein is entered the tourniquet is removed, the needle taped to the skin and the contrast material injected.

splint. A 10 cc. syringe filled with sterile saline or distilled water is connected to the hub end of the polyethylene tube, the air is flushed out, and the needle (no. 23), held by a hemostat, is introduced into the skin over the superficial vein. While the assistant holding the syringe pulls back very gently on the plunger, the needle is passed parallel to and into the vein (Fig. 2). As soon as entrance is made, blood immediately appears in the transparent tubing. The hemostat is then released and the needle taped securely to the skin. A small amount of the saline or water is then injected. If a wheal appears, the needle is withdrawn and the process repeated at a different site. When it is certain that extravasation of the saline is not occurring, the syringe containing the contrast material is connected to the hub of the catheter and the contrast material injected, observing the skin in the area of the needle constantly for signs of subcutaneous extravasation. As soon as the injection is begun, the infant is given a bottle containing a sweet carbonated beverage and films are obtained at five minutes, ten minutes, fifteen minutes, and thirty minutes after the injection. An additional film is made after the infant voids. The carbonated drink serves not only to demonstrate the kidneys through the air-filled stomach but quiets the infant, and greatly facilitates the taking of films. The time interval between the ingestion of the beverage and the last roentgenogram is not long enough to interfere with the preparatory dehydration.

The amount of contrast material injected is 0.5 cc. per pound, if 70 per cent urokon is used, or 0.7 cc. per pound, if 50 per cent hypaque is used. These are arbitrary quantities which we have found satisfactory. The infusion set with attached polyethylene tubing (B–D scalp vein infusion set) may be purchased from Becton, Dickinson and Company or the tubing may be obtained separately from Clay Adams Company (P.E.—50) and an ordinary no. 23, short bevel, $1\frac{1}{2}$ inch needle cut to fit the tubing. The set is sterilized by immersion in zephiran chloride solution (1:1000) for a minimal period of eighteen hours.

SUMMARY

A technique for performing intravenous pyelography in infants utilizing the intravenous infusion set devised by Murphy and

Gardner is described and a brief discussion of the difficulties encountered in obtaining satisfactory excretory pyelograms in infants is given.

Edward B. Singleton, M.D.
6621 Fannin Street
Houston 25, Texas

REFERENCES

1. Berg, O. C., and Allen, D. H. Use of carbonated beverages as aid in pediatric excretory urography. *J. Urol.*, 1952, *67*, 393–396.
2. Epstein, B. S. Carbonic acid as contrast medium in radiography of infants and children. *J. Pediat.*, 1955, *47*, 218–221.
3. Gardner, L. I., and Murphy, J. T. New needle for pediatric scalp vein infusions. *Am. J. Dis. Child.*, 1950, *80*, 303–304.
4. Hope, J. W., and Campoy, F. Use of carbonated beverages in excretory urography. *Radiology*, 1955, *64*, 66–71.
5. Hunt, H. B., and Popma, A. M. Excretory urography by intramuscular injection of diodrast. *Radiology*, 1938, *31*, 587–594.
6. Mathei, L. P. Improved pediatric excretory urography. *J. Urol.*, 1950, *64*, 417–420.
7. Nesbit, R. M., and Douglas, D. B. Subcutaneous administration of diodrast for pyelograms in infants. *J. Urol.*, 1939, *42*, 709–712.
8. Singleton, E. B. Intestinal obstruction in infants. *J. Pediat.*, 1954, *44*, 159–171.
9. Warres, H. L., and King, A. C. Hyaluronidase in intramuscular excretory urography. *Radiology*, 1954, *63*, 730–733.
10. Wasch, M. G., and Marck, A. Radiographic appearance of gastro-intestinal tract during the first day of life. *J. Pediat.*, 1948, *32*, 479.

MULTIPLE GIANT URETERAL CALCULI*

By C. L. HINKEL, M.D., *and* G. A. MOLLER, M.D.
DANVILLE, PENNSYLVANIA

ALTHOUGH there is great variability in the roentgenologic appearance of ureteral calculi, in general they tend to be small, single, and irregular. About 50 per cent of ureteral calculi are less than 5 mm. in diameter[4] and about 93 per cent are single.[1] Most ureteral calculi are presumed to be secondary, having their origin in the kidney from which they descend into the ureter. Occasionally very large stones are encountered. The term "giant" has been applied to concretions which exceed 5 cm. in length or circumference.[11] Peculiarly, these giant calculi (which presumably attain their size by intra-ureteral growth) are usually single. Most of them have been in the left ureter.[12] The largest calculus thus far reported is that of Mayers,[9] which measured 11 by 5.5 by 5 cm. and weighed 286 grams.

Muschat and Kaplan[11] who reviewed the literature dealing with giant calculi, classified them into two types: (1) calculi formed in the ureter and consisting of inspissated pus and epithelial debris, and (2) calculi from the kidney which grow by accretion in the ureter.

Calculi of the first type (pus and debris) are long and cigar-like or corkscrew shaped. Such calculi are usually found in the lower third of the ureter. They extend upward to form a cast of this structure, and may attain considerable length. Taylor[12] has reported one 21 cm. long. Frequently they are channeled or grooved, permitting the passage of some urine. The so-called "cigar" calculus usually lacks organized internal structure. It is in fact a closely packed elongated mass of gravel-like material containing pus, epithelial debris, and calcium salts. When the ureter is sufficiently dilated to permit urine to surround the calculus, there may also be some growth in circumference. This is no doubt augmented by the localized granular and ulcerative ureteritis which is usually present.

Calculi of the second type are true concretions formed by colloid-crystalloid deposition upon a nidus which presumably descended from the kidney and came to rest in a dilated partially obstructed ureter. Calculi developing under such conditions are identical with those formed in the renal pelvis or in the urinary bladder. They tend to be spherical or ovoid in shape. On cut section they show radial crystalline architecture and concentric laminations. These are less frequently seen than the "cigar" or "corkscrew" varieties.

It has been emphasized by Dourmashkin[3] that the growth of calculi is promoted if they are surrounded by a wide urine-filled ureter. Conversely, growth is inhibited if the calculi are tightly wedged into a narrow or constricted ureter.

The two classical types of calculi described above are not always distinguishable on the basis of gross external appearance. A few of the large ovoid stones have some of the characteristics of both types. Some of the giant calculi reported in the literature cannot be classified since cut sections or roentgenograms of the specimens are not available.

GROWTH OF URETERAL CALCULI

Calculi in the urinary tract, particularly in the ureter, grow best when they are in a large cavity in which they are constantly bathed in sluggish urine. It must be emphasized that complete ureteral obstruction does not favor the growth of calculi, since it results in defunctionalization of the kidney. The organic colloid-crystalloid substances necessary for precipitation and accretion are therefore absent. When the ureter is di-

* From the Department of Radiology, The George F. Geisinger Memorial Hospital and Foss Clinic, Danville, Pennsylvania.

lated and incompletely obstructed, conditions are ideal for calculus growth.

The speed of growth of ureteral calculi is variable. Dourmashkin,[4] who reported a series of 1,550 patients with ureteral calculi, noted no calculus growth during his period of observation. Other authors have mentioned definite increase in size over a period of several months.[5,11,13] We have seen renal and vesical calculi enlarge slightly during three months of observation, but we have observed no patients with ureteral calculi for a sufficient length of time to measure growth of the calculus. The "cigar" calculus in the ureter of Burkland's patient[2] was observed to grow in length from 7.5 cm. to 16 cm. in twenty-eight years.

We wish to present and to discuss a patient without urological symptoms who was found to have multiple, large, dense, smoothly rounded calculi in the left ureter.

CASE REPORT

A white male aged sixty-three was admitted to the Medical Service of the George F. Geisinger Memorial Hospital on March 24, 1953, complaining of burning pain in his right anterior thigh and posterior aspect of the right calf. This pain had been present for six months prior to admission. There was also epigastric pain and distress which was worse after meals and relieved by saline cathartics. There were no urinary tract symptoms or past history of genitourinary disease. The only positive physical findings on admission were hypertension of 150/90 and mild epigastric tenderness without a palpable mass. The prostate was slightly enlarged.

FIG. 1. Plain film of the pelvis. The cluster of ovoid densities is projected through the left sacral wing, simulating inspissated barium in the sigmoid.

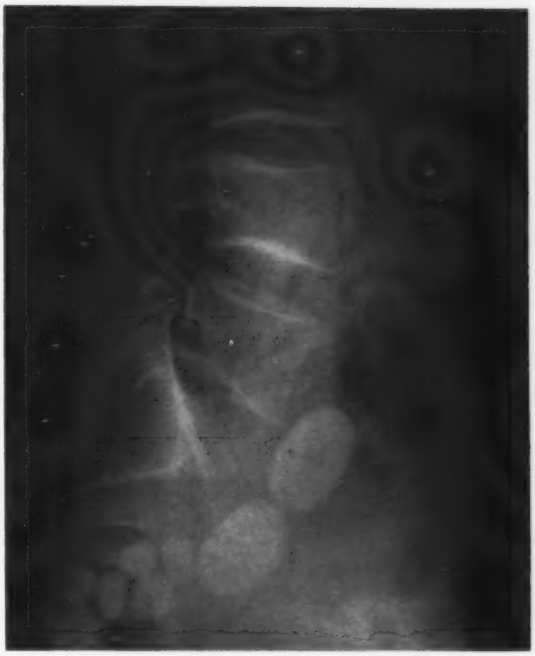


FIG. 2. Lateral film of lumbar spine. The calculi follow the hollow of the sacrum and extend upward to the lumbosacral junction.

Laboratory Findings. Admission urinalysis showed 15 mg. of albumin per 100 cc. and 53 white blood cells per high power field. The reaction was acid. *E. coli* was cultured from the urine. Nonprotein nitrogen was 44 mg. per 100 cc. Serology, acid phosphatase, serum amylase, calcium, phosphorus, and complete blood cell count were within normal limits.

Roentgenologic Examinations. The calculi were first discovered as an incidental finding by the fluoroscopist during examination of the upper gastrointestinal tract. They appeared as a cluster of calcific densities projected through the left side of the bony pelvis (Fig. 1). They were in the expected position of the rectum and sigmoid (Fig. 2). An intravenous urogram was done and the calculi were found to be within the dilated left ureter (Fig. 3*A*). When the patient was placed in the Trendelenburg position the calculi migrated cephalad (Fig. 3*B*). The left kidney functioned poorly and showed a moderate degree of hydronephrosis. These

FIG. 3. Intravenous urogram. (*A*) Supine. There is moderate hydronephrosis on the left. The ureter containing the calculi is dilated and elongated. (*B*) Trendelenburg position. The calculi are freely movable. Two small stones can be seen in the dilated ureter behind the bladder. The others have moved cephalad.

findings were confirmed by cystoscopy and retrograde pyelography.

Cystoscopy. There was a Grade 1 trilobar hypertrophy of the prostate, with early bladder trabeculations of the obstructive type. The bladder was otherwise negative. The right ureteral meatus appeared to be normal with clear urine spurting from it. A ureteral catheter passed easily to the right renal pelvis.

The left ureteral meatus appeared to be normal but there was no urine spurting from it. A No. 5 French ureteral catheter encountered an obstruction 2 cm. above the left ureterovesical junction. After manipulation and further introduction of the catheter, a rapid continuous drip of clear urine was obtained.

Operation. A left ureterolithotomy was performed on April 7, 1953, through a left lower quadrant incision. The ureter was markedyl dilated below the brim of the pelvis, being at least 3 to 4 cm. in diameter. Its wall was thin and there were very few adhesions. There was active ureteral peristalsis. Many stones were palpated in the lower segment of the ureter. These were removed and the ureter was closed. There was no demonstrable narrowing of the ureter or the ureterovesical junction.

Operative Specimen. There were twenty smooth, glistening, brown-black calculi (Fig. 4). They varied from 1 to 3.7 cm. in diameter. Chemical analysis showed calcium oxalate in layers. Surface cracks were present in some. When the calculi were studied roentgenologically after removal, central radial fissures were found (Fig. 5). These have not been described previously in renal or ureteral calculi, but they have been reported in biliary calculi.[6]

Subsequent Course. The patient had an un-

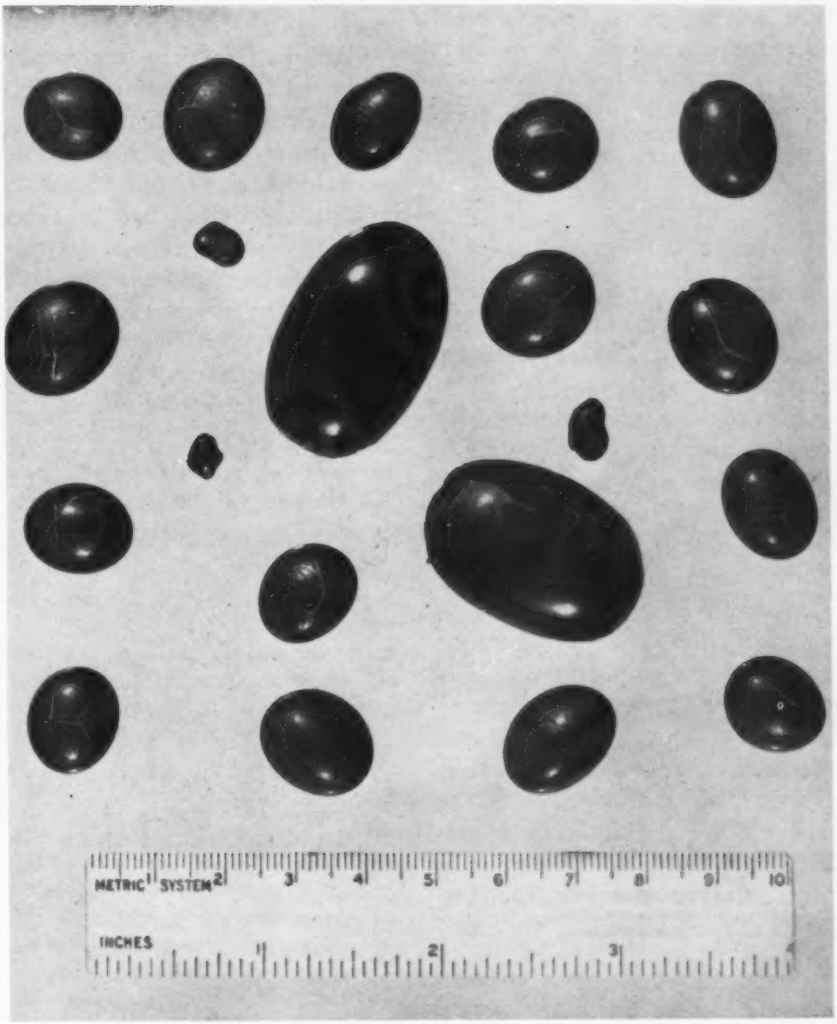


FIG. 4. Photograph of the calculi. They are dark brown and smoothly polished. Many show surface cracks.

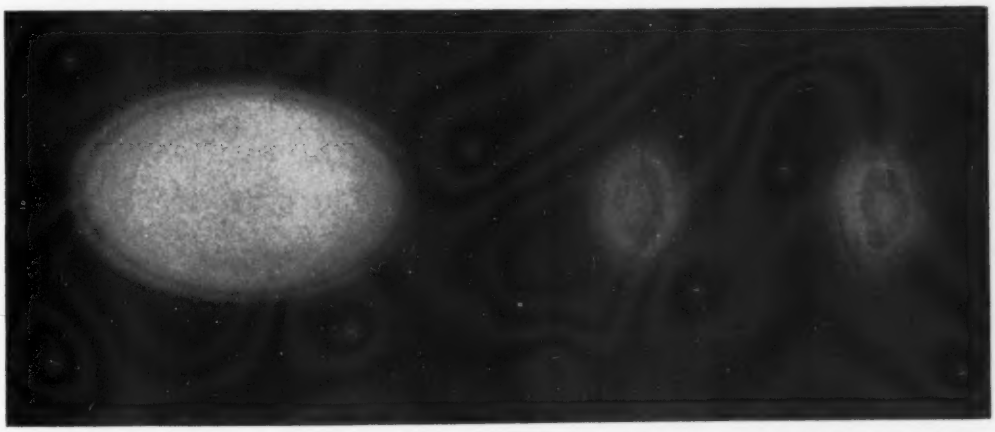


FIG. 5. Roentgenogram of three characteristic calculi. Laminations of varying densities are seen in all. The crystal arrangement is radial and the two smaller calculi contain internal cracks or fissures.

eventful postoperative course and was followed in the Out Patient Clinic. All postoperative urine studies were negative. Intravenous urograms over a period of seven months revealed no change in left renal function or in the diameter of the left ureter. No further calculi have formed to date.

DISCUSSION

Patients harboring giant ureteral calculi usually have few symptoms of urologic disease. Our patient is typical in this respect. The striking lack of symptoms is well illustrated in the case of the woman reported by Burkland.[2] She had a long "cigar" calculus in the ureter for eight years, but it did not interfere with her professional dancing career until it was fractured during coitus.

While mild infection is frequently found in patients having ovoid giant calculi, this is seldom severe. Probably the absence of complete obstruction is important in this connection as well as the amount of renal damage produced by back pressure. In our patient, as well as in previously reported cases, the hydronephrosis was only moderate and renal function was retained on the involved side. Had the obstruction been complete or the renal function lost, the presumption is that the calculi would not have grown by accretion.

The partial obstruction associated with giant calculi has been attributed by other authors to: congenital anomaly,[9] trauma,[8] poliomyelitis,[10] fibrous stricture of the ureter,[2] ureterocele,[7,12] and diverticulum.[3]

In our patient no organic narrowing of the ureter or of its orifice was found at operation. It appears that a calculus itself may have been responsible for the original partial obstruction which progressed to dilatation, stagnation and calculus growth. It is our belief that following the initial obstruction, subsequent calculi may have originated and grown in the ureter. Probably the crystal formation is analogous to that occurring in a partially obstructed gallbladder.

SUMMARY

Multiple, smooth, freely movable, giant ureteral calculi, such as are reported here, may occur in patients without urinary symptoms. Under certain conditions calculi increase in size in the ureter. Optimum growth conditions are provided by a dilated, partially obstructed hypotonic ureter filled with sluggishly moving urine. Preservation of renal function on the involved side is necessary for continued accretion. It is suggested that some of the calculi in our patient were ureterogenic.

C. L. Hinkel, M.D.
George F. Geisinger Memorial Hospital
Danville, Pennsylvania

REFERENCES

1. BRAASCH, W. F., and EMMETT, J. L. Clinical Urography. W. B. Saunders Company, Philadelphia, 1951.
2. BURKLAND, C. Fracture of giant ureteral calculus. *J. Urol.*, 1953, *69*, 366–371.
3. DODSON, A. I. Ureteral diverticula with large stone and undeveloped kidney. *J. Urol.*, 1944, *52*, 526–535.
4. DOURMASHKIN, R. L. Cystoscopic treatment of stones in ureter with special reference to large calculi; based on study of 1550 cases. *J. Urol.*, 1945, *54*, 245–283.
5. FRESHMAN, E. Case of renal and ureteral calculi of unusual size; repeated formation of calculi. *Brit. J. Surg.*, 1933, *21*, 63–66.
6. HINKEL, C. L. Gas-containing biliary calculi. AM. J. ROENTGENOL. & RAD. THERAPY, 1950, *64*, 617–623.
7. LOEB, M. J. Large ureteral calculus; report of case. *Urol. & Cutan. Rev.*, 1943, *47*, 518–520.
8. MARANGOS, G., and PORTER, G. E. Ureteral calculus of unusual size. *Brit. J. Surg.*, 1945, *32*, 524–525.
9. MAYERS, M. M. Giant ureteral calculus (weight: 286 gms.). *J. Urol.*, 1940, *44*, 47–53.
10. MCKAY, H. W., and BAIRD, H. H. Giant ureteral stone in three-year-old child. *South. M. J.*, 1947, *40*, 891–892.
11. MUSCHAT, M., and KAPLAN, H. Formation of large stones within the ureter. *Urol. & Cutan. Rev.*, 1937, *41*, 153–157.
12. TAYLOR, W. N. Large ureteral calculi. *J. Urol.*, 1934, *32*, 93–102.
13. WILHELMI, O. J. Management of recurrent giant calculi. *Urol. & Cutan. Rev.*, 1944, *48*, 187–192.

Vol. 75, No. 5

THE ROENTGENOGRAPHIC DEMONSTRATION OF AN ARTERIOVENOUS FISTULA OF RENAL VESSELS

By ANTHONY P. GARRITANO, M.D.,* GEORGE T. WOHL, M.D.,†
CHARLES K. KIRBY, M.D.,‡ *and* ANTHONY L. PIETROLUONGO, M.D.§
PHILADELPHIA, PENNSYLVANIA

ARTERIOVENOUS fistula of renal vessels is a rare condition. Only 5 previous cases have been reported. This sixth case is of considerable interest in that: (1) the clinical diagnosis was suspected on the basis of a typical intra-abdominal murmur; and (2) the accurate preoperative roentgen demonstration was possible through the use of translumbar aortography.

REPORT OF CASE

This twenty-two year old white male was transferred from the Wilkes-Barre Veterans Hospital for further evaluation of a loud bruit heard in the left upper quadrant of the abdomen. The patient had noted recent weakness and exertional dyspnea. He had never noted orthopnea, ankle edema, cough or hemoptysis. He rarely complained of headaches or other symptoms of significance. The important observations in his past medical history were two traumatic events of possible significance relative to the present consideration. In September, 1951, he fell 20 feet through the hatch of a naval vessel sustaining a moderately severe blow to the back. He then complained of aching for several days. In July, 1952, he sustained a gunshot wound of the chest. The bullet entered in the right anterior axillary region at the level of the 4th interspace and remained in the body. For two days after this injury, traces of blood were said to have been found in the urine. The bullet, at the time of admission, was lodged in the dome of the liver beneath the right diaphragm. On physical examination the patient appeared to be a well developed, well nourished male in no apparent distress. Clinical evidence of cardiac enlargement of a moderate degree was present. A loud precordial systolic murmur was heard. The significant observation was the presence of a loud continuous machinery-like murmur audible in the left upper quadrant of the abdomen anteriorly and posteriorly. Blood pressures were noted as follows: sitting 180/60; lying 150/60; pulse 80. Physical examination was otherwise not remarkable. Blood and urine studies by routine methods were normal (white blood cell count, 7,200; red blood cell count, 5.39 million; hemoglobin, 14.5 gm.). The venous pressure in an antecubital vein measured one hundred thirty millimeters of water. An electrocardiographic examination demonstrated an increase in the amplitude of the QRS complexes in the precordial leads, but was otherwise not abnormal. On the initial chest roentgen study a 30 per cent cardiac enlargement, left ventricular in nature, was found and a bullet was noted in the liver just beneath the dome of the right diaphragm. This study was otherwise normal. A preoperative intravenous urogram (Fig. 1) demonstrated excellent concentration of the contrast medium in both kidneys, bilaterally symmetrical renal contour and normally appearing pelvo-calyceal systems. There was a moderate lateral deviation of the proximal third of the left ureter just distal to the uretero-pelvic junction.

Since preoperative demonstration of the abdominal vascular abnormality was desirable, translumbar percutaneous aortography was performed using the Fairchild camera. Serial films were exposed at half second intervals over a fifteen second period immediately following the injection of 25 cc. of 70 percent urokon sodium. The point of the needle was located in the aorta about 1½ inches proximal to the celiac axis. Opposite the normal right renal artery and at the same level there was immediate but transient filling of a large vascular structure showing peripheral sacculations which simulated the calyces of a hydronephrotic kidney (Fig. 2). Of considerable importance in

* Instructor in Radiology, Jefferson Medical College Hospital, Philadelphia, Pennsylvania.
† Chief, Radiological Service.
‡ Consultant in Surgery from the University of Pennsylvania Hospital.
§ Chief, Laboratory Service.
Veterans Administration Hospital, University and Woodland Avenue, Philadelphia, Pennsylvania.

Fig. 1. Intravenous urogram demonstrating a normal outline of both kidneys with good concentration of the opaque medium in normal pelvocalyceal systems. There is a lateral deviation of the upper portion of the left ureter between the levels of the second and fourth lumbar vertebrae.

the accurate identification of this mass was the presence of a conical-shaped, inferiorly located structure that, by anatomic location, was suggestive of a dilated spermatic vein. No contrast material appeared in the aorta below the level of the renal arteries. The position of the arteriovenous fistula itself was demonstrated by visualization of both the arterial and venous components of the opacified communication. The major portion of the opacified mass with peripheral sacculations represented the markedly dilated renal vein and its branches.

Operation was performed on January 7, 1954 (C.K.K.). A left thoraco-abdominal incision was made, beginning in the 7th interspace with the patient in the right lateral position. The left diaphragm was incised radially, half-way to the esophageal hiatus. Hernia tapes were passed around the aorta just above the level of the diaphragm and below the inferior mesenteric artery so that hemorrhage due to a technical accident could be minimized. The large aneurysmal sac was then exposed. It extended over most of the anterior surface of the kidney and up over the spleen anteriorly. There were a number of rather large out-pouchings, the limits of which were well demarcated by the strong thrill. The wall of the sac was thinner than that of a normal vein in many places but fortunately was not perforated at any time and

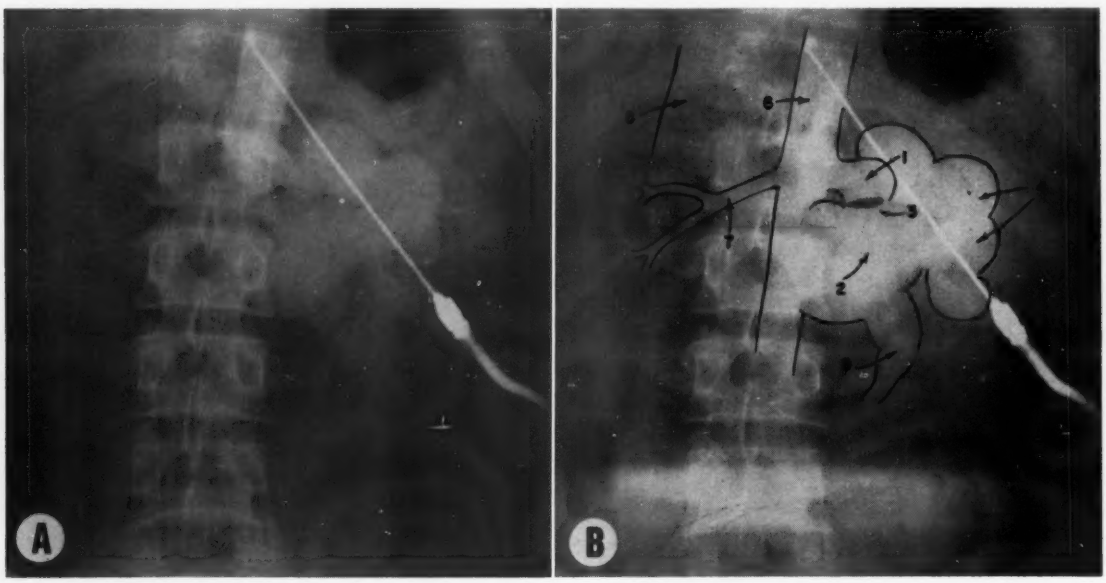


Fig. 2. Lumbar aortogram, (*A*) without and (*B*) with superimposed line drawing, demonstrating (1) aneurysmal arterial component; (2) dilated renal vein; (3) location of fistula formation; (4) venous sacculations; (5) dilated spermatic vein; (6) opacified aorta; (7) right renal artery; and (8) faintly opacified inferior vena cava.

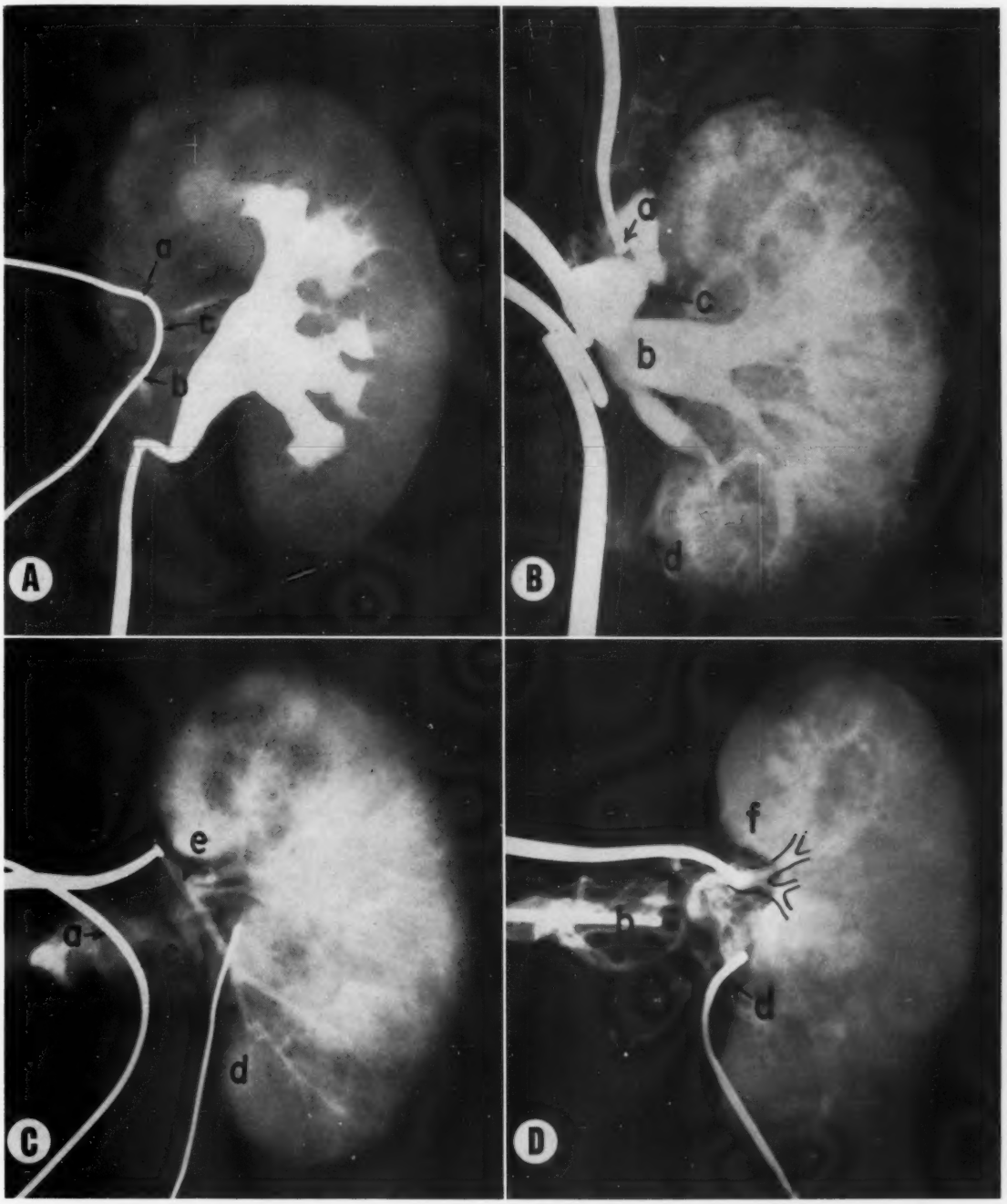


FIG. 3. Roentgenograms of left kidney specimen after the injection of 70 per cent urokon sodium into (*A*) the ureter and pelvis (*d*); (*B*) the arterial component of the fistula (*a*); (*C*) the separate second renal artery (*e*); and (*D*) the remainder of the involved renal artery (*f*). In *A* and *C*, a probe has been inserted into the arterial aneurysm (*a*), and protrudes through the dilated renal vein at the point of transection (*b*), as it passes through the fistula (*c*). The renal vein has been occluded by clamps (*B*) to allow filling of the intrarenal venous branches with the opaque material. A probe has been placed in the ureter (*C* and *D*), and another at the site of the dissected renal vein (*D*).

These roentgenograms demonstrate (1) a normal pelvo-calyceal system (*A*); (2) intrarenal venous branches (*B*); (3) the normal branching of the separate second renal artery (*C*); and (4) the branching of the remainder of the involved renal artery, diagrammatically emphasized (*D*).

there was no significant bleeding during the dissection. None of the veins of the portal system were involved. It appeared that the safest procedure was to approach the arterial end of the fistula by exposing the aorta from above and below. Cautious dissection posteriorly finally led to exposure of the base of the left renal artery, occlusion of which obliterated the thrill. Nephrectomy was obviously necessary. The renal artery was first ligated and divided. This reduced the pressure in the huge venous sac and permitted safe dissection of the rest of the vascular pedicle which was then secured with suture ligatures and divided. The ureter was then ligated and divided and the specimen was removed. The patient was in good condition throughout the procedure. There were mild alterations of blood pressure and immediately following removal of the kidney the pressure dropped to 100/70. It came up quickly again, however, and obliteration of the fistula did not appear to cause any significant immediate effect.

Within two weeks, the blood pressure had slowly returned to normal values, stabilizing at an average of 120/74 mm. mercury. A comparative chest roentgen study on the thirteenth postoperative day demonstrated return of the heart to normal size and contour. The patient was discharged on the eighteenth postoperative day. He has been seen since and has remained in good health. Examination of the removed specimen revealed a direct fistulous communication measuring 0.8 cm. in diameter, between a large aneurysmally dilated renal artery and the markedly dilated renal vein.

The removed specimen was then studied roentgenographically. Injection of contrast material into the pelvo-calyceal system through the cannulated ureter was accomplished. The subsequent film demonstrated a normal pelvocalyceal system (Fig. 3*A*). Next, the renal vein was clamped at the point of transection and the renal artery was cannulated and injected. A film following this procedure (Fig. 3*B*) essentially duplicated the preoperative roentgen demonstration of the vascular lesion. On further dissection in the surgical pathology laboratory, two additional findings of importance were noted: (1) a second renal artery was discovered posteriorly to, and separate from, the dilated main renal artery; and (2) the main renal artery appeared to exist as a blind sacculation. The occlusion was not complete, however, and the main renal artery, while diminished to a pin point lumen for a distance of 1 cm. beyond the aneurysm, then returned to almost normal caliber. Both the newly discovered artery and the remainder of the main renal artery were injected with contrast material as illustrated in Figure 3, *C* and *D*. Both arteries distributed branches throughout the renal parenchyma. This dual arterial supply was effective in maintaining renal circulation and was responsible for the normal excretory urogram and the normal appearing renal parenchyma on histologic section.

Anson and Cauldwell,[2] in a study of 425 anatomic dissections of renal arteries in man, found that this variation of double arterial supply is relatively common. The lesion and associated renal changes are shown in the artist's drawing (Fig. 4, *A* and *B*).

The pathologic report substantiated the above findings. The kidney itself was normal in size. Multiple histologic sections demonstrated a normal cortico-medullary histologic pattern. The narrowed arterial segment distal to the aneurysmal sac showed almost complete obliteration of the lumen as the result of extensive fibrosis, and the dilated venous and arterial vessels displayed subintimal fibrous proliferation.

DISCUSSION

The first case of arteriovenous aneurysm of renal vessels reported by Varela[19] in 1928 and proved at autopsy, was that of a twenty-eight year old male with cardiac decompensation, hypertension, and a bruit in the right lumbar area. A similar case, which, however, was cured by nephrectomy, was reported by Rieder[18] in 1942. In Varela's case, it was felt that the fistula may have been due to erosion from a congenital aneurysm of the renal artery. This was similarly supposed in Rieder's case, except that a history of a right flank injury two years previously was also mentioned. Pearse and MacMillan[15] reported the third case in 1947. Clinically, this case demonstrated only gross hematuria. No other physical findings were present. Nephrectomy was performed, and the fistula found was thought to have developed as a result of an erosion between both an arterial and a venous aneurysm. In 1950, Hamilton, Getz, and Jerome[7] discovered the fourth

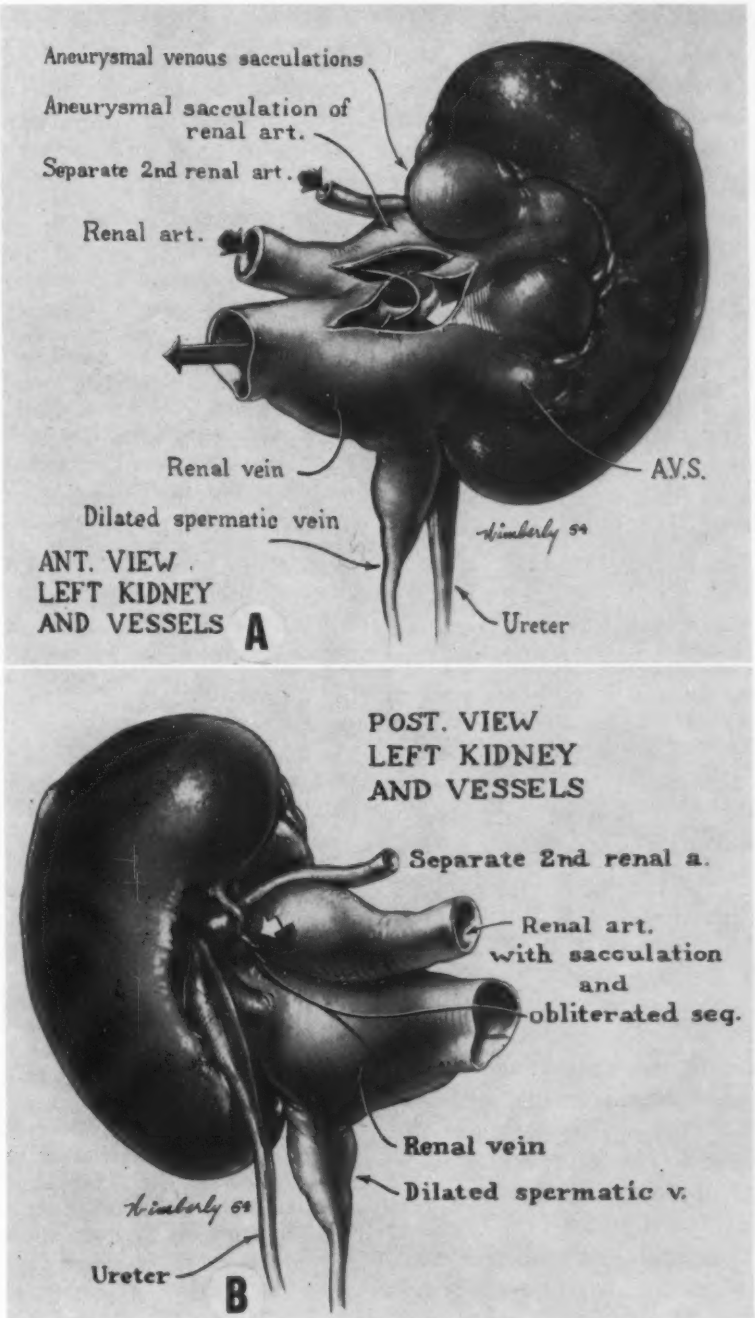


Fig. 4. Artist's drawing of (*A*) the anterior view and (*B*) the posterior view of the left kidney and vessels.

case of an arteriovenous fistula of the left kidney. In their case, the findings of hypertension and a loud bruit over the left renal area led to the preoperative suspicion of such a fistula. This was later proved to be the case when a nephrectomy was performed, at which time an unusual finding was revealed. The arteriovenous fistula was found to have developed secondarily to an adenocarcinoma of the left

kidney after the carcinomatous growth had extended into the left renal vein. No other similar case is found in the literature. The fifth case of arteriovenous fistula of renal vessels found in the literature was reported by Adams[1] in 1951 and, in this case, the right kidney was involved. There is the possibility in our patient that the fistula was the result of an erosion of a congenital renal artery aneurysm into the renal vein. We cannot overlook, however, the two previous traumatic events and their possible etiologic relationship to this lesion. Even though the bullet was found in the dome of the liver, it could still have been possible for an unusual ricochet of the projectile against the left iliac bone to have involved the renal pedicle, even if only adjacent tissues were injured. The history of two occasions of red blood cells in the urinalyses as noted above may therefore be significant.

Reid[16] states that an arteriovenous fistula invariably causes secondary changes in the arterial component even with eventual aneurysmal dilatation of the artery. The aneurysmal arterial dilatation in our patient could well have been on this basis if the fistula was traumatic in nature. The cardiovascular changes seen in this patient are the usual sequelae of arteriovenous fistula formation. Cardiac enlargement, as noted preoperatively in this patient, for example, is a common occurrence in the presence of arteriovenous fistulas of sufficient size.[4,5,8,9,10,16,17] The lowering of the diastolic pressure is one of the obviously expected blood pressure changes noted in cases of fistula formation.[10,11,16,17] The elevation of the systolic pressure in this case, however, parallels the experimental evidence of Lasher and Glenn,[12] who have shown that an elevation of the systolic pressure is produced by arteriovenous fistulas occurring only in renal vessels. The return of the heart to normal size and function, after the removal of the fistula in the absence of irreversible cardiac damage as we have observed, is also a fact commonly reported in the literature.[4,5,9,10,16]

In untreated cases of arteriovenous fistulas of sufficient size, there are certain complications which may eventually occur, the most common one being almost certain cardiac failure.[4,5,9,10,17] The other complications that may occur are: (1) hypertension in cases of involvement of the renal vessels;[7,12,18,19] (2) bacterial endocarditis;[3,13,14] and (3) rupture of an associated renal artery aneurysm.[6,20]

SUMMARY

The sixth proved case of arteriovenous fistula of renal vessels has been presented. Accurate preoperative demonstration was possible for the first time by the use of lumbar aortography. The renal vascular abnormality has been completely described. A normal pelvo-calyceal outline with good concentration of opaque material in an intravenous urogram does not rule out pathology of renal vessels.

Dr. George T. Wohl
Veterans Administration Hospital
University and Woodland Avenues
Philadelphia 4, Pennsylvania

REFERENCES

1. Adams, H. D. Congenital arteriovenous and cirsoid aneurysms. *Surg., Gynec. & Obst.*, 1951, *92*, 693–697.
2. Anson, B. J., and Cauldwell, E. W. Pararenal vascular system; study of 425 anatomic specimens. *Quart. Bull., Northwestern Univ. M. School*, 1947, *21*, 320–328.
3. Bobb, J. R. R., Wargo, J. D. M., and Visscher, M. B. Comparative susceptibility to endocarditis and glomerulonephritis in dogs with and without arteriovenous shunts. *Journal-Lancet*, 1951, *71*, 455–461.
4. Drury, A. N. Observations relating to cardiac hypertrophy produced in rabbit by arteriovenous anastomosis; effect of closure of anastomosis. *Quart. J. Exper. Physiol.*, 1945, *33*, 107–112.
5. Elkin, D. C., and Warren, J. V. Arteriovenous fistulas; their effect on circulation. *J.A.M.A.* 1947, *134*, 1524–1528.
6. Hack, R. W. Rupture of aneurysm of left renal artery during pregnancy. *Am. J. Obst. & Gynec.*, 1953, *65*, 1142–1145.
7. Hamilton, G. R., Getz, R. J., and Jerome, S. Arteriovenous fistula of renal vessels; case report and review of literature. *J. Urol.*, 1953, *69*, 203–207.

8. Harrison, T. R., Dock, W., and Holman, E. Experimental studies in arteriovenous fistulae; cardiac output. *Heart.* 1924, *11*, 337–341.
9. Hines, E. A. Jr., and Waugh, J. M. Congestive heart failure; result of arteriovenous fistula; report of case. *Proc. Staff Meet. Mayo Clin.*, 1936, *11*, 545–548.
10. Holman, E. Clinical and experimental observations on arteriovenous fistulae. *Ann. Surg.*, 1940, *112*, 840–878.
11. Kennedy, J. A., and Burwell, C. S. Measurements of circulation in patient with multiple arteriovenous connections. *Am. Heart J.*, 1944, *28*, 133–148.
12. Lasher, E. P. Jr., and Glenn, F. Effects on kidney and blood pressure of artificial communication between renal artery and vein. *Arch. Surg.*, 1939, *38*, 886–905.
13. Lillehei, C. W., Bobb, J. R. R., and Visscher, M. B. Occurrence of endocarditis with valvular deformities in dogs with arteriovenous fistulae. (18082). *Proc. Soc. Exper. Biol. & Med.*, 1950, *75*, 9–16.
14. Parmley, L. F., Jr., Orbison, J. A., Hughes, C. W., and Mattingly, T. W. Acquired arteriovenous fistulas complicated by endarteritis, and endocarditis lenta due to *Streptococcus faecalis*. *New England J. Med.*, 1954, *250*, 305–309.
15. Pearse, R., and MacMillan, R. L. Congenital aneurysm of renal artery. *J. Urol.*, 1947, *58*, 235–238.
16. Reid, M. R. Abnormal arteriovenous communications, acquired and congenital. III. Effects of abnormal arteriovenous communications on heart, blood vessels and other structures. *Arch. Surg.*, 1925, *11*, 25–42.
17. Reid, M. R., and McGuire, J. Arteriovenous aneurysms. *Ann. Surg.*, 1938, *108*, 643–693.
18. Rieder, W. Sonderstellung arterio-venöser Aneurysmen der Nierengefässe in Rahmen operativer Behandlung schwerer Herz-Kreislaufschäden beim arterio-venösen Aneurysma. *Chirurg.*, 1942, *14*, 609–618.
19. Varela, M. E. Aneurisma arteriovenoso de los vasos renales y asistolia consecutiva. *Rev. méd. latino-am.*, 1928, *14*, 3244–3266.
20. von Ronnen, J. R. Roentgen diagnosis of calcified aneurysms of splenic and renal arteries. *Acta radiol.*, 1953, *39*, 386–400.

ADDENDUM

Since this paper was submitted for publication, another case of arteriovenous fistula of the renal vessels was reported by Baron and Koenemann in January, 1955. The lesion, occurring as the result of trauma in a seven year old female child, was intrarenal in location and did not involve the hilar vessels, as was noted in our case.

REFERENCE

Baron, G. J., and Koenemann, R. H. Arterio venous fistula of renal vessels. *Radiology*, 1955, *64*, 85–87.

AN UNUSUAL CASE OF LINDAU'S DISEASE*

CYSTIC DISEASE OF THE KIDNEYS AND PANCREAS WITH RENAL AND CEREBELLAR TUMORS

By FRANK ISAAC, M.D., IRWIN SCHOEN, M.D., *and* PHYLLIS WALKER, M.D.
LONG BEACH, CALIFORNIA

LINDAU'S disease is a rare entity characterized by angiomatous cysts of the cerebellum and tumors or cysts of the abdominal organs, chiefly the pancreas and the kidneys. It is often, though by no means invariably, associated with angiomatosis of the retina (von Hippel-Lindau's disease).

The roentgen literature contains surprisingly little information on this interesting entity. Save for occasional brief references in several textbooks[18] no case report of Lindau's disease has appeared in the American roentgen literature as far as we could discover. Because of several remarkable features encountered in a case of Lindau's disease, we believe that presentation of this case history in some detail is well justified.

REPORT OF CASE

The patient, D.C.H., a thirty-two year old white married male, was admitted to the medical service at the Long Beach Veterans Administration Hospital on April 24, 1953, with complaints of nausea and vomiting of increasing severity during the past eight months. He lost 30 pounds in the past one and one half years.

Eleven years previously, at the age of twenty-one, while on active duty in the Army, he began to have frontal headaches and gradually increasing diminution of visual acuity. In August, 1942, he was operated on for a suspected brain tumor. No tumor was found, but the patient improved following surgery. He was given a medical discharge in 1943, with a diagnosis of arachnoiditis.

Because of recurrence of headaches and appearance of cerebellar symptoms, slurring of speech and increasing clumsiness of the limbs, he was reoperated on in February, 1948, at a Naval hospital. At this time a tumor was found in the right cerebellar hemisphere. It was described as a lobulated cystic structure, which bled freely and could not be completely removed because part of it was lying on the brain stem. The microscopic diagnosis was reported as hemangioblastoma.

During the next two years he was given three courses of deep roentgen therapy to the posterior fossa. The details of the various factors used or the total dose of radiation is not known to us, but after the last course of roentgen therapy in 1950, his cerebellar symptoms remained stationary. Since the latter part of 1950, he was followed in the out-patient clinic of this hospital. He was seen by the neurosurgical department from time to time, but no definitive therapy was thought to be indicated, except symptomatically.

In October, 1951, he began to have intermittent attacks of painless hematuria, sometimes accompanied by chills and fever. Because of these attacks, during the next eighteen months he was seen repeatedly by the urologists in the out-patient clinic and once hospitalized on the genitourinary service for a period of six weeks. Examinations disclosed a gradually enlarging tumor mass in the right upper abdomen and, eventually, a smaller mass in the left upper abdomen. Repeated pyelographic studies strongly suggested bilateral polycystic disease. However, in view of the marked distortion of the right collecting structures, neoplasm of the right kidney was thought to be a strong possibility (Fig. 1, *A* and *B*).

His admission to the Medical Service in April, 1953, was prompted by the gradually increasing nausea and vomiting and the marked weight loss.

The family history is interesting. His mother died in her twenties of unknown cause. A sister had surgery for brain tumor with good results, but died in an automobile accident five years later. A brother, four years older than the patient, had a brain tumor removed and is now blind.

Physical examination revealed a thin, chronically ill-appearing man with slow, hesitant speech. He was friendly and cooperative and somewhat euphoric. The blood pressure was

* From the Departments of Radiology, Pathology and Medicine, Veterans Administration Hospital, Long Beach, California.

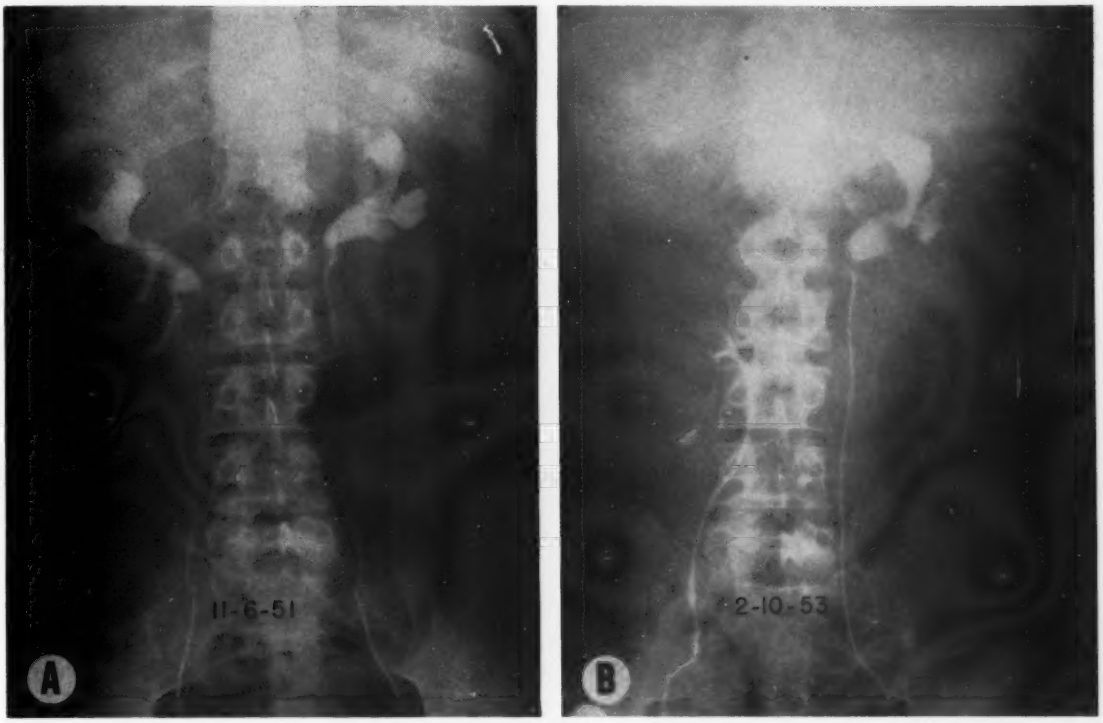


Fig. 1. Retrograde pyelograms. (*A*) Marked distortion of the collecting structures of the right kidney, indicating multiple cysts. The lower calyx of the left kidney is blocked out, presumably by a large cyst. (*B*) Fifteen months later. Marked increase in the size of the right kidney and much greater distortion of the calyceal system. The left kidney shows no significant change.

110 systolic and 76 diastolic. Pulse and temperature were normal. Pupils reacted to light. Both disks were pale but there was no evidence of increased intracranial pressure. The retinae were easily visualized and although a number of vessels were somewhat tortuous, no vascular malformations or angiomata were seen. The visual acuity was moderately decreased bilaterally. Gross nystagmus was present in all directions. There were bilateral neocerebellar signs. The tendon reflexes were physiologic.

Abdominal examination disclosed a large palpable mass on each side, the right being larger than the left. Laboratory findings were not remarkable except for urinalysis, which showed three plus albumin and a sediment loaded with white and red blood cells. Blood urea nitrogen was 19 mg. per cent.

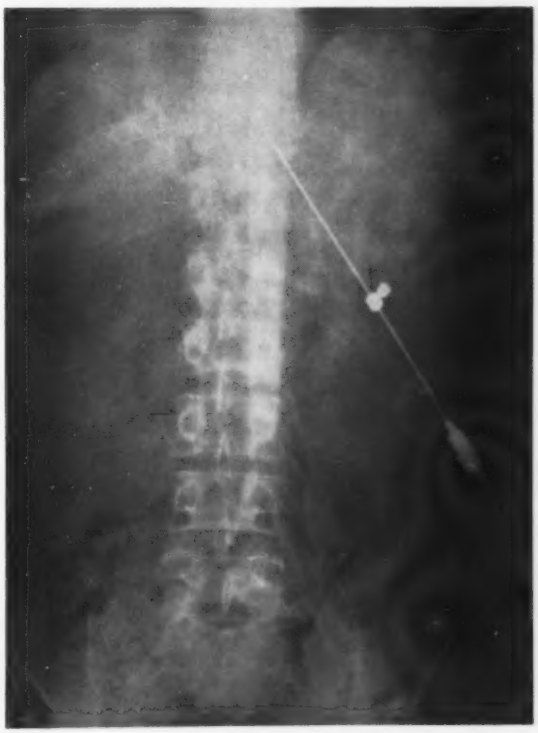


Fig. 2. Abdominal aortogram. Note the abnormal vascular pattern of the right renal artery, with extensive capillary "staining" suggesting a highly vascular tumor mass. The spherical shadows in both upper quadrants probably represent metastatic nodules in the lung bases.

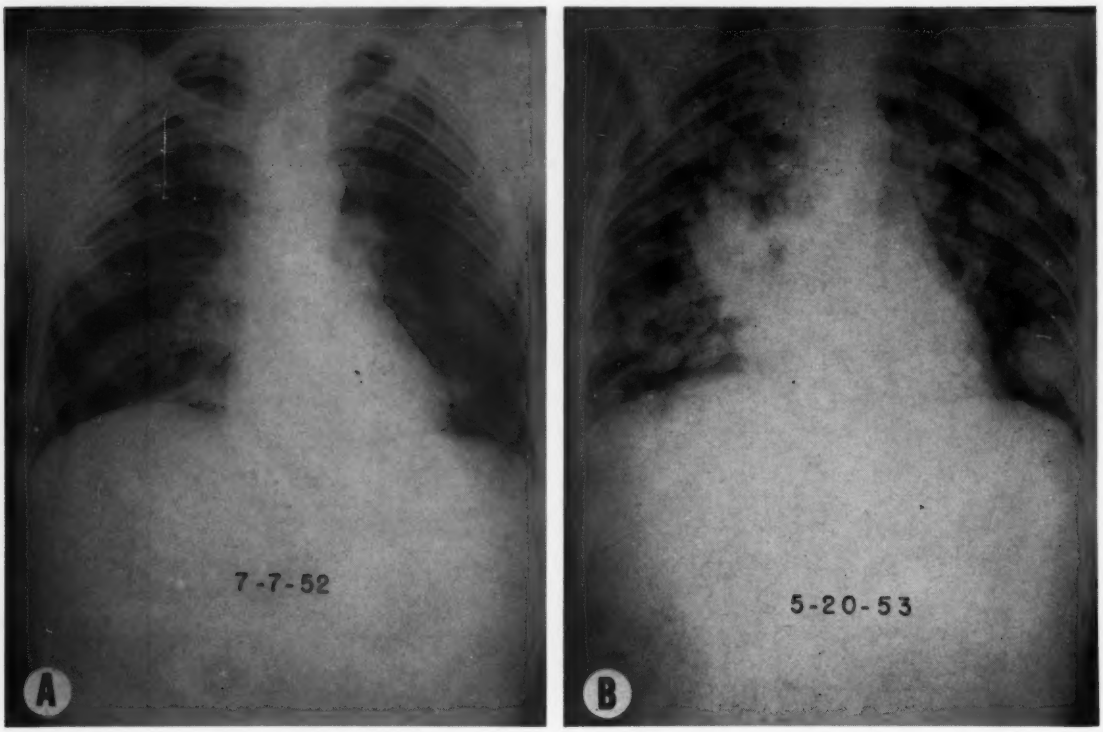


FIG. 3. (*A*) Negative chest film. (*B*) Ten months later. Extensive nodular metastases. A large nodule in the right base is cavitating.

Excretory urograms done on May 6, 1953, demonstrated that there had been a definite and marked increase in the size of the right kidney mass during the past three months. Abdominal aortogram revealed numerous small blood vessels and capillaries replacing the normal renal vascular pattern and apparently outlining a large tumor mass in the right kidney (Fig. 2).

Contrary to usual routine procedure, a chest film was not taken until approximately one month after admission, on June 20, 1953. This disclosed numerous nodular shadows scattered throughout both lungs, obviously representing extensive pulmonary metastases (Fig. 3). A repeat chest film one month later showed marked increase both in the size and number of the metastatic nodules and fluid in both pleural spaces.

The course was rapidly down-hill, and the patient expired in acute respiratory failure two months after his hospital admission.

The pertinent postmortem findings were as follows: The pleural surfaces were studded with tumor masses and the lungs contained numerous tumor nodules, some with necrotic foci (Fig. 6). The myocardium, in the region of the left ventricle, also contained several grossly identifiable small tumor nodules, the largest 0.5 cm. in diameter (Fig. 7, *C*). The hilar lymph nodes were involved with tumor.

The pancreas, on cut section, revealed a large number of cysts, measuring up to 2.0 cm. in diameter and filled with clear watery or slightly mucoid fluid (Fig. 7, *A* and *B*).

The liver was moderately congested, but neither it nor the spleen contained tumors, cysts or angiomas.

The right kidney showed numerous cysts, measuring up to 3.0 cm. in diameter. The cysts were filled with clear watery and bloody fluid and replaced a major portion of the renal parenchyma. In the midportion of this kidney there was a somewhat well demarcated, massive tumor approximately 5.0 cm. in diameter. The tumor extended into the right renal vein partially occluding the lumen (Fig. 4). The left kidney was similar in appearance, with cysts replacing much of the renal parenchyma. In this kidney, there were several discrete tumor nodules, each about 1.5 cm. in diameter, resembling in appearance the large mass in the right

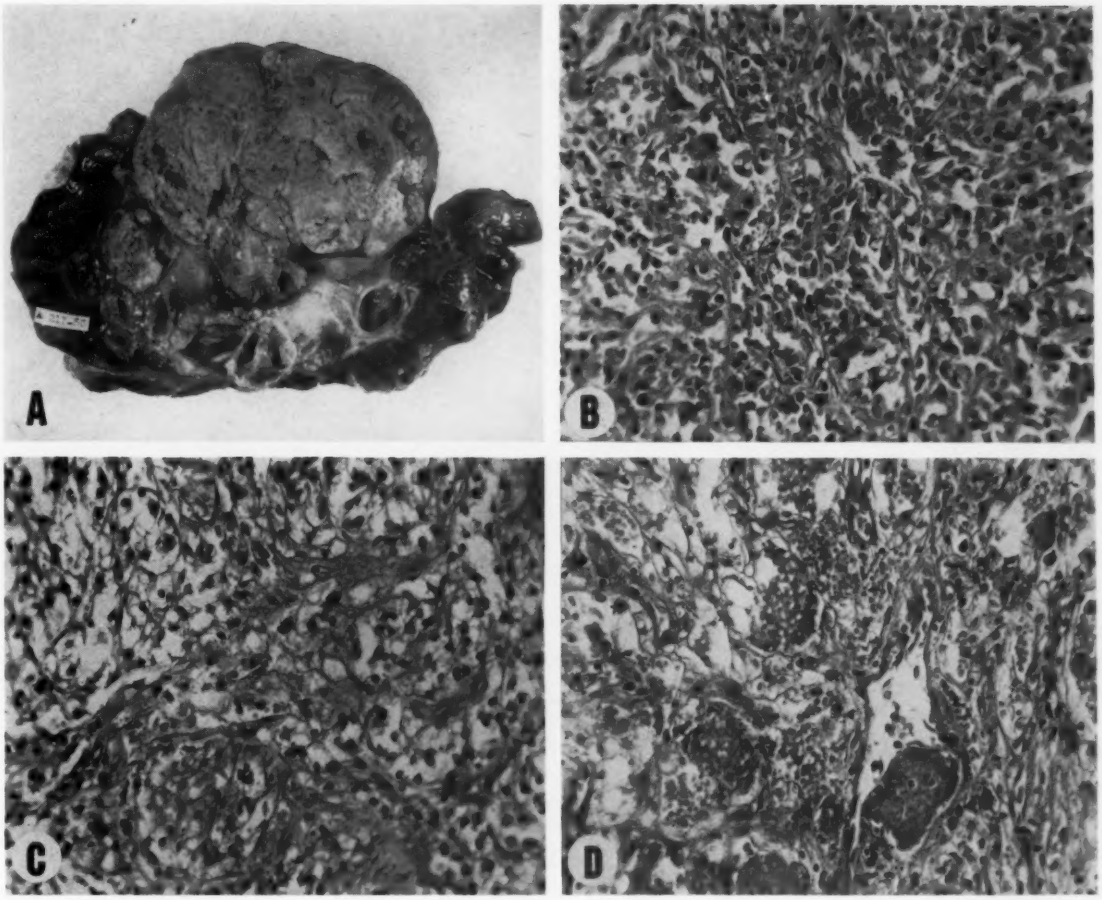


Fig. 4. Right kidney. (*A*) Gross specimen showing multiple cysts and large tumor mass. (*B*, *C*, and *D*) Microscopic fields through tumor showing granular cell, clear cell, and vascular patterns respectively. (×300.)

kidney. Retroperitoneal lymph nodes were found to be involved with tumor.

Brain. The major portion of the right cerebellar hemisphere was occupied by a massive tumor measuring 4.5 cm. in diameter which extended to the adjacent portions of the medulla. This tumor was grossly similar in appearance to the metastatic lesions in the chest and the tumors in the kidneys (Fig. 5).

The eyes were not dissected in view of the negative fundoscopic examination during the lifetime of the patient.

Microscopic Examination. Numerous sections of all tumor-bearing areas revealed a varied pattern. This ranged from tubular to alveolar and to sheet-like aggregations of clear cells or granular cells with varying degrees of nuclear pleomorphism. There was a microscopic focus of tumor found in the adrenal. There also were varying degrees of vascularization, degeneration and sclerosis in some areas of the kidney tumor and even more in the cerebellum where the vascular areas suggested angiomatous or hemangioblastomatous pattern (Fig. 5, *D*). The cysts of the kidney and the pancreas were for the most part epithelial lined (Fig. 7, *B*). The renal cysts had areas of proliferation and papillary hyperplasia, mostly of clear cell type epithelium (Fig. 7, *D* and *E*).

DISCUSSION

Angiomatous tumors or cysts of the cerebellum often occur without retinal involvement and indeed, without involvement of any other organ. Dandy,[4] in 1928, collected 24 cases of cerebellar angiomatous cysts, including 7 of his own. In less than 10 per cent of these was there any coincident involvement of the retina and apparently in

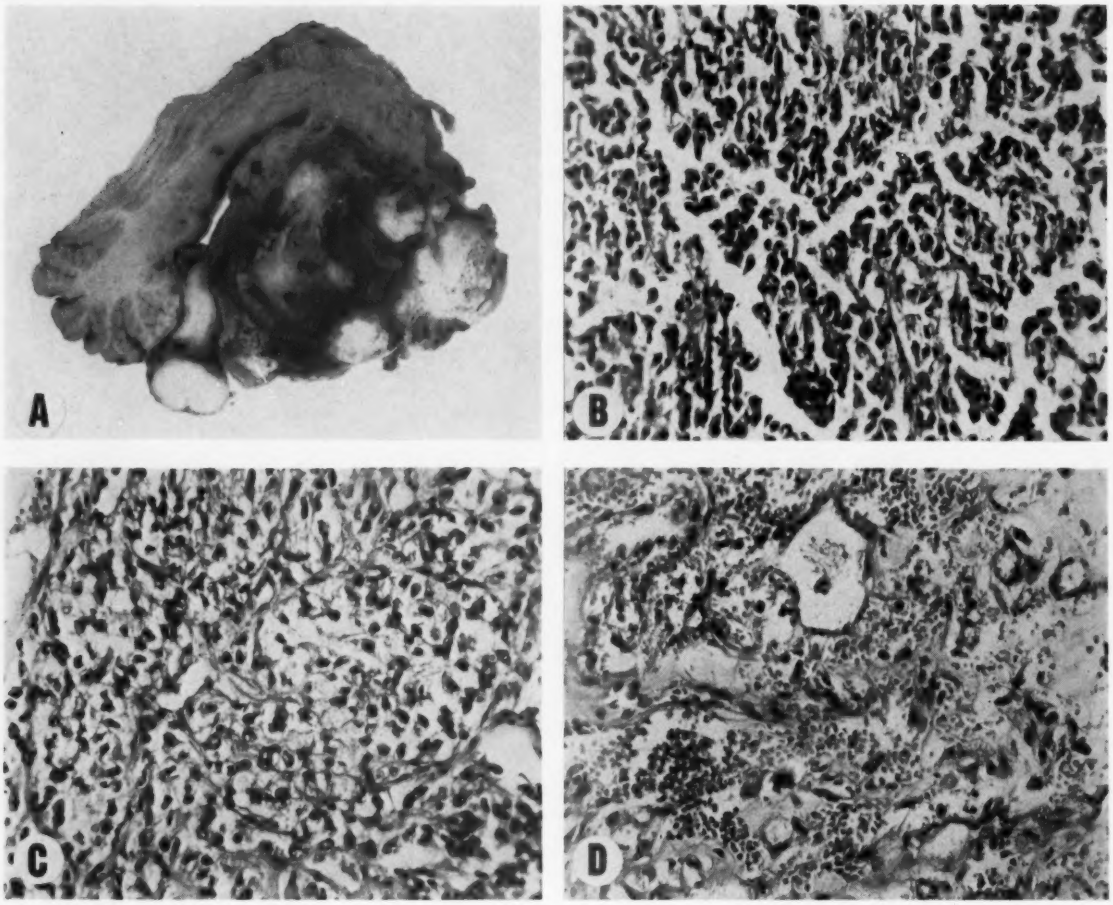


FIG. 5. Cerebellum. (*A*) Gross specimen. Cut section shows tumor with dark hemorrhagic vascular areas and nodular, light, cellular areas. (*B*, *C*, and *D*) Microscopic fields showing granular, clear cell, and vascular patterns respectively. Note that the angiomatous area shows pleomorphic and larger lining cells than the corresponding area in the kidney tumor. (×300.)

none was there any involvement of any of the abdominal organs.

Bailey,[1] on the other hand, while admitting that either hemangioma of the retina or hemangioblastoma of the cerebellum may occur alone, feels that both are probably simply a partial manifestation of a larger pathologic complex. This line of reasoning is also expressed by Silver and Hennigar,[16] who in a recent critical review of 40 cases of cerebellar hemangiomas found 9 cases (22.5 per cent) associated with Lindau's disease. According to these authors, this high incidence raises the strong possibility that all patients with cerebellar hemangiomas might have Lindau's disease, with the other features of the complex not yet in evidence.

The case reported here, although only a single one of this kind in our experience, tends to support this point of view. In this patient, the first symptoms of cerebellar tumor appeared in 1942, at the age of twenty-one. Yet symptoms and signs referable to a renal lesion did not appear until October, 1951, almost ten years later. It might be justifiable to say, therefore, that every patient in whom a cerebellar angiomatous lesion has been found, should be followed by excretory urography at least once a year.

The sequence of events encountered here, however, is also significant from another

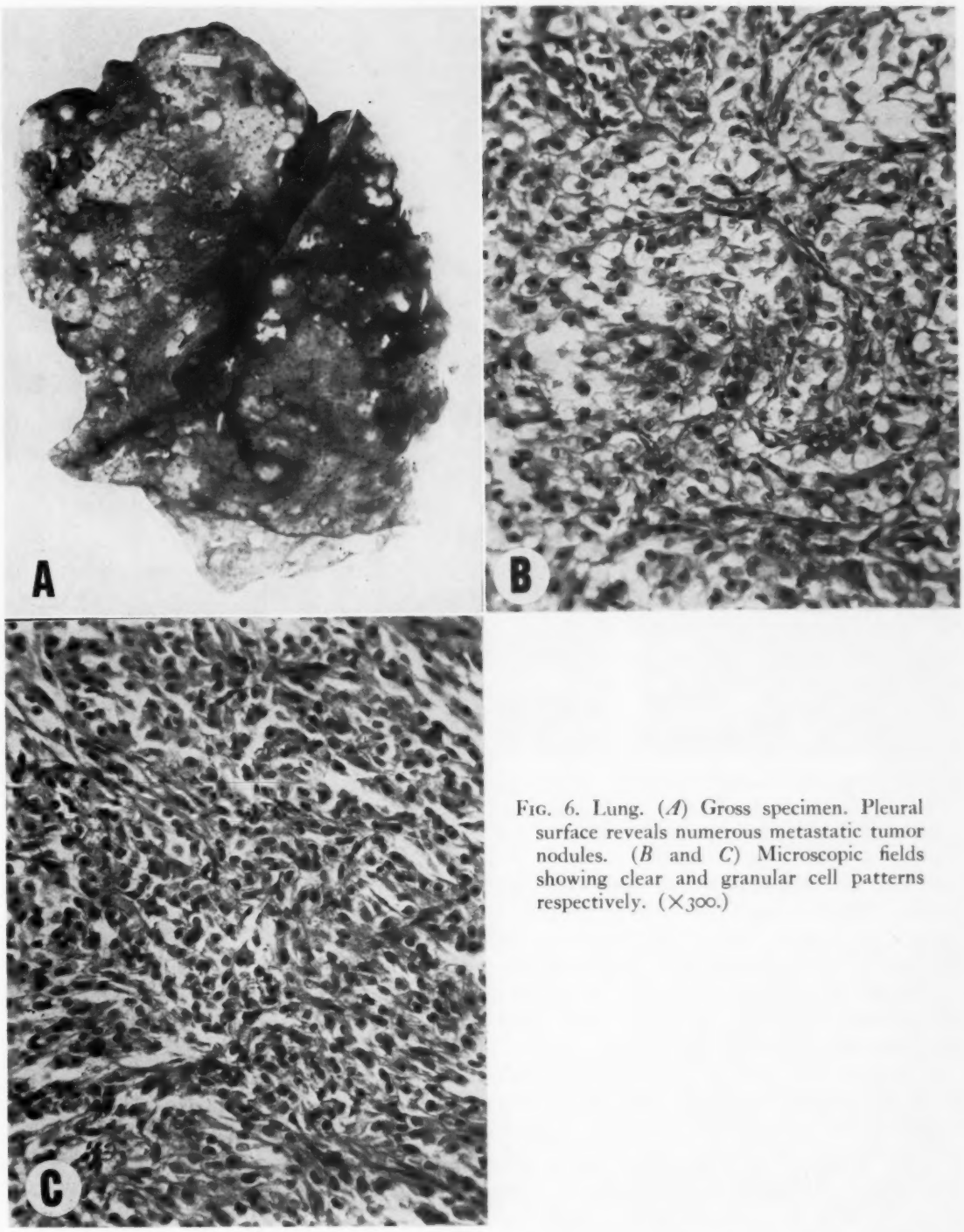


Fig. 6. Lung. (*A*) Gross specimen. Pleural surface reveals numerous metastatic tumor nodules. (*B* and *C*) Microscopic fields showing clear and granular cell patterns respectively. (×300.)

point of view. Perhaps, the most remarkable feature of the postmortem examination was the finding of a massive tumor in the cerebellum occupying the previous site of surgery. Histologically, this tumor was thought to be identical with the renal carcinoma and the tumor found in the lungs. The question, therefore, naturally arises

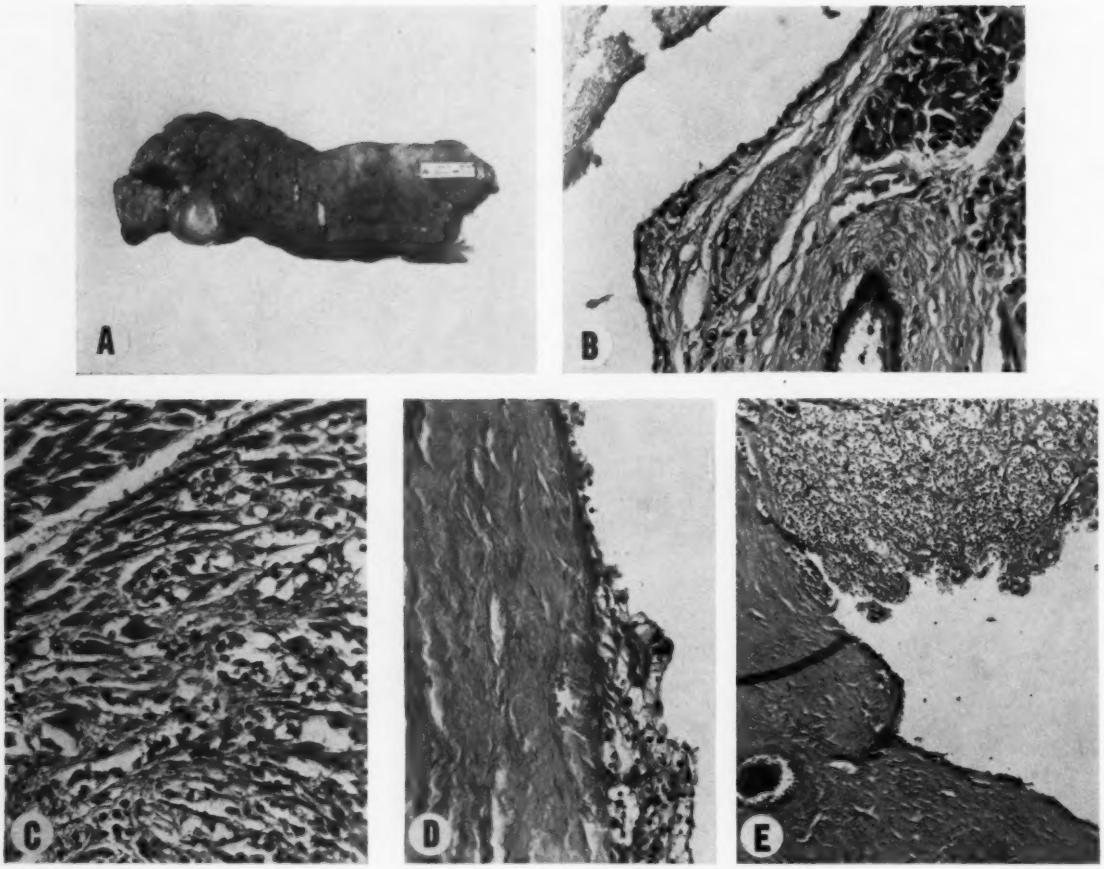


FIG. 7. (*A* and *B*) Pancreas. Gross and microscopic appearance, showing epithelial-lined cysts. (*C*) Heart muscle. (*D* and *E*) Microscopic fields of renal cysts showing epithelial lining, clear cell hyperplasia, and clear cell tumor transitions. (×300 and ×100.)

whether the original tumor found in the cerebellum five years previously might not have been a metastatic hypernephroma in the first place. This possiblity might appear all the more plausible since the microscopic appearance of hemangioblastoma and renal carcinoma may be quite similar.[1]

Unfortunately, it was not possible to review the original surgical material. Strong objection, however, can be raised against this attractive theory on the basis of the long survival. Rupp[14] in reviewing 42 cases of metastatic brain tumors in which the intracranial lesions were the only metastatic foci discovered on autopsy, found the longest duration of life from the onset of symptoms to be two years. Our patient survived more than eleven years after the onset of cerebellar symptoms.

The alternative line of reasoning, then, must assume that the patient did have a hemangioblastoma of the cerebellum treated by surgery and roentgen therapy and to any residual tumor tissue which may still have been there, tumor cells from the kidney eventually metastasized.

Strictly from the point of view of tissue diagnosis, all the pathologists who reviewed the autopsy material agreed that this was a case of primary renal carcinoma with metastases to the lungs and cerebellum. Some, however, reasoned that the tumor in the cerebellum represented metastasis to a pre-existing angiomatous lesion. It is not difficult to accept this reasoning when we consider that the cerebellar tumor exhibited highly vascular areas in places suggesting an almost hemangioblastoma-

tous pattern (Fig. 5, *D*). With the methodology and knowledge available at this time, one's conclusion is, after all, based on one's visual memory, experience and opinion. It is the opinion of the authors that the cerebellar tumor represents the unusual occurrence of a tumor metastasizing to a tumor.

One might, perhaps, also speculate on the mesodermal origin of hypernephroma. The obvious gross invasion of the renal vein readily accounts for the vascular distribution of the metastases to the lungs, heart and brain.[2] But assuming diffuse and universal dissemination of tumor cells, the selectivity and mechanism of tumor cell survival and growth in these locations may be related to this common vascular-mesodermal tumor and soil relationship.

It has been often suggested recently that the association of renal carcinoma with renal cysts is of such frequency as to indicate a causal relationship.[5] This might suggest a multicentric origin of renal cancer in polycystic disease and could explain the bilateral occurrence of tumors of similar histopathology in this case. The other possibility, of course, is that the larger tumor with frank renal vein invasion from the right kidney metastasized to the left kidney.

SUMMARY AND CONCLUSIONS

1. A case of Lindau's disease has been presented with several unusual features.

2. The disease is characterized by angiomatous tumor of the cerebellum, often extending to the brain stem and associated with cysts or tumors of any of the abdominal organs, particularly the pancreas, polycystic disease of the kidneys and hypernephroma.

3. Evidence of this pathologic complex may appear many years after the first appearance of symptoms of cerebellar tumor.

4. It may or may not be associated with angiomatosis retinae (von Hippel's disease).

5. The disease has a strong tendency to be familial.

6. The finding of cerebellar metastases from the renal tumor on autopsy posed an interesting problem in this case. Alternative possibilities have been explored and the opinion offered that here we are dealing with the unusual occurrence of a tumor metastasizing to a tumor.

7. It is suggested that every patient with a cerebellar vascular tumor should be followed by excretory urography.

Frank Isaac, M.D.
Veterans Administration Hospital
Long Beach, California

We would like to express our appreciation to Mr. Thomas S. Masterson and Mr. Timothy Dodge of the Medical Illustration Department for their excellent work in preparing the illustrations for this paper.

REFERENCES

1. Bailey, P. Intracranial Tumors. Second edition. Charles C Thomas, Publisher, Springfield, Illinois, 1948, pp. 185–204.
2. Coman, D. R. Mechanisms responsible for origin and distribution of blood-borne tumor metastases; review. *Cancer Research*, 1953, *13*, 397–404.
3. Cushing, H. G., and Bailey, P. B. Tumors Arising from the Blood Vessels of the Brain. Angiomatous Malformations and Hemangioblastomas. Charles C Thomas, Publisher, Springfield, Illinois, 1928, pp. 9.
4. Dandy, W. E. Venous abnormalities and angiomas of brain. *Arch. Surg.*, 1928, *17*, 715–793.
5. Gibson, T. F. Interrelationship of renal cysts and tumors; report of three cases. *J. Urol.*, 1954, *71*, 241–252.
6. Golden, R. Diagnostic Roentgenology. Thomas Nelson & Sons, New York, 1948, pp. 32F.
7. Greene, L. F., and Rosenthal, M. H. Multiple hypernephromas of kidney in association with Lindau's disease. *New England J. Med.*, 1951. *244*, 633–634.
8. von Hippel, E. Über eine sehr seltene Erkrangung der Netzhaut. *Arch. f. Ophth.*, 1904, *59*, 83–106.
9. Kernohan, J. W., Waltman, H. W., and Adson, A. W. Intramedullary tumors of spinal cord; review of 51 cases with attempt at histologic classification. *Arch. Neurol. & Psychiat.*, 1931, *25*, 679–701.
10. Lindau, A. Studien über Kleinhirncysten. Bau, Pathogenese und Beziehungen zur Angiomatosis Retinae. *Acta path. et microbiol. Scandinav.*, 1926, Suppl. *1*, 1–128.
11. Lindau, A. Zur Frage der Angiomatosis Retinae

und ihrer Hirnkomplikationen. *Acta ophth.*, 1927, *4*, 193–226.

12. MOLLER, H. U. Familial angiomatosis retinae et cerebelli (Lindau's disease). *Acta ophth.*, 1929, *7*, 244–260.
13. NICCOL, W., and MOORE, R. F. Case of angiomatosis retinae. *Brit. J. Ophth.*, 1934, *18*, 454–457.
14. RUPP, C. Metastatic tumors of central nervous system. *Arch. Neurol. & Psychiat.*, 1948, *59*, 635–645.
15. SARGENT, F., and GREENFIELD, J. G. Hemangiomatous cysts of cerebellum. *Brit. J. Surg.*, 1929, *17*, 84–101.
16. SILVER, M. L., and HENNIGAR, G. J. Cerebellar hemangioma (hemangioblastoma); clinicopathological review of 40 cases. *Neurosurgery*, 1952, *9*, 484–494.
17. STAZ, L. Angiomatosis retinae; with report of 4 cases in one family involving 6 eyes. *Brit. J. Ophth.*, 1941, *25*, 167–179.
18. WALSH, F. B. Clinical Neuro-Ophthalmology. Williams & Wilkins Company, Baltimore, 1947, pp. 1088–1093.

CYSTITIS EMPHYSEMATOSA*

CASE REPORT

By PAUL FRANCKE, JR., M.D., *and* JAMES W. LANE, M.D.

CHARLESTON, WEST VIRGINIA

VESICLES of gas within the urinary bladder wall are infrequently seen. Eisenlohr[1] in 1888, first described this condition as an autopsy finding. Mills[5] in 1930, based on a series of 12 cases, expressed the belief that this is not only a postmortem phenomenon but one that occurs during life. Ravich and Katzen[7] in 1932, proved him to be correct. An emergency cystotomy in a fifty-six year old male revealed the vesicles within the bladder wall. Since then 22 other cases have been recognized during life and reported, the most recent by Faingold, Hansen and Rigler,[2] Wheeler,[9] and Packard, Beazlie and Creecy.[6] About one-half of these were diagnosed roentgenographically.

The cause of cystitis emphysematosa is a gas producing organism, Escherichia coli being found frequently, and Clostridium welchii occasionally. The condition occurs in both sexes, predominantly in adults; one case has been reported in infancy.[8] More than one-half of the patients reported in the literature had had diabetes, which apparently is a predisposing factor.

The most common symptoms of cystitis emphysematosa are frequent urination and dysuria, and occasionally hematuria and pneumaturia; however, in some cases no symptoms referable to the urinary bladder were present.

REPORT OF A CASE

A sixty-one year old white male developed pain in his right lower quadrant and right costovertebral angle. This was present for about one week and was increasing in severity. There was no dysuria, hematuria or pneumaturia. Nocturia and slowness of the urinary stream were present for about two years. The patient was an alcoholic and had been drinking daily up to the time of his admission.

The physical examination revealed moderate tenderness in the right lower quadrant of the abdomen and in the right costovertebral angle, associated with some muscle spasm in the right lower quadrant. The bladder was not palpable. His temperature was elevated. Essential laboratory findings on admission were a three plus albuminuria with numerous white blood cells and an occasional red blood cell in the urine. Glycosuria was not present. (A glucose tolerance test performed two months after onset of illness was within normal limits.) There was a white blood cell count of 17,700 with 84 per cent polymorphonuclear leukocytes and 16 per cent lymphocytes.

Pyelonephritis and appendicitis were considered tentatively in the diagnosis, and the patient was given gantrisin, 1 gm. every six hours, with some improvement. One day later, December 25, 1954, a plain film of the abdomen (Fig. 1) revealed the presence of gas in the bladder wall. On this basis a diagnosis of cystitis emphysematosa was made. An intravenous pyelogram on the following day (Fig. 2 and 3) showed distention of the bladder and numerous pockets of air within the bladder wall. A cystoscopic examination on December 27, 1954, revealed the following: The urine was clear in appearance; there was heavy trabeculation of the bladder wall, the result of a contracture of the bladder neck; scattered over the fundus were numerous small vesicles which varied in size from 1 mm. to over 1 cm. and tended to be arranged in several groups; in a few places over the vesicles the mucosa was hemorrhagic, but there was not a generalized severe cystitis. Two biopsy specimens were taken from the surface of the

* From the St. Francis Hospital, Charleston, West Virginia.

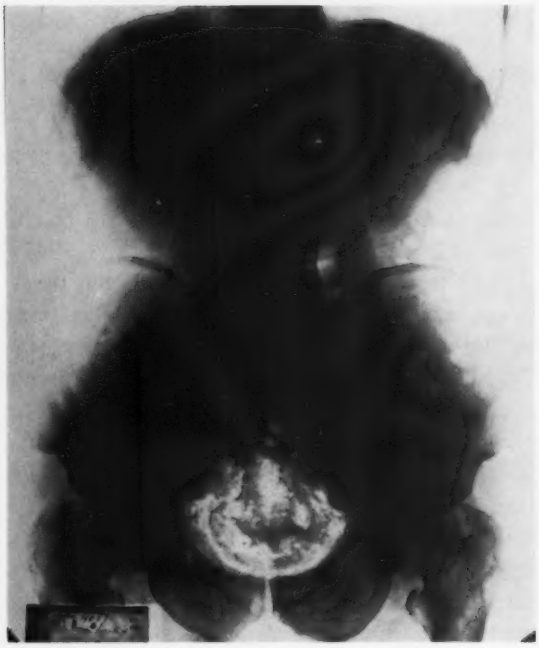


FIG. 1. Scout film of abdomen, December 25, 1954. The wall of the bladder contains numerous areas of radiolucency. These areas are ovoid and semilinear in form and vary in size. Notice the acorn appearance of the bladder due to pressure from the bowel on each side of the fundus of the empty but erect bladder.

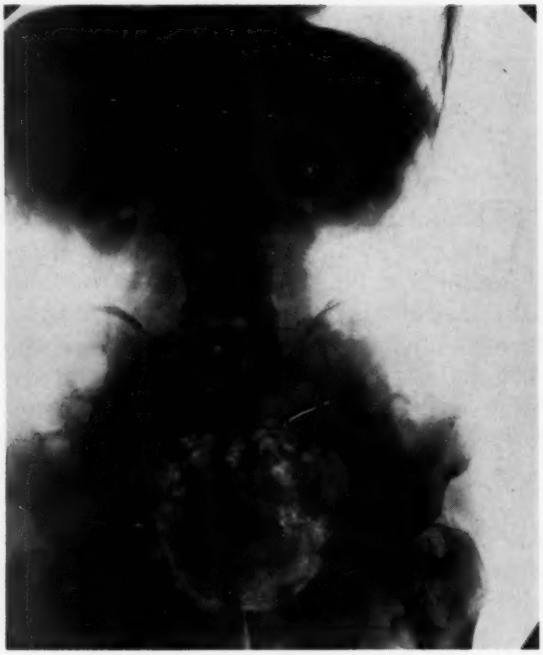


FIG. 2. Intravenous pyelogram, December 26, 1954. The upper urinary tract appears normal. The bladder is distended and contains opaque medium. Numerous radiolucent areas can be observed due to carbon dioxide between the trabeculae and under the mucosa.

largest vesicles using the biopsy forceps. A cystogram revealed much improvement in the appearance of the bladder as compared to the previous films (Fig. 4).

Cultures of the urine in gelatin on the third day of hospitalization demonstrated Escherichia coli forming pockets of gas in the medium. No growths occurred in the anaerobic cultures. The biopsy sections showed the covering epithelium to be intact and there was slight sprinkling of chronic inflammatory cells in the stroma.

The patient made an uneventful recovery. Films of the abdomen six weeks later did not reveal the presence of urinary gas.

A review of the literature disclosed several interesting features in connection with this disease. Thus, Mills[5] reported on the difficulty experienced in obtaining sections for microscopic study. He found it necessary to first fix the bladder in solution of formaldehyde for several days until it had

FIG. 3. Intravenous pyelogram, upright film. A fluid level can be made out in the bladder from rupture of vesicles. Spontaneous bursting of the vesicles has been observed during cystoscopy.

Fig. 4. Cystogram, December 27, 1954. There are less radiolucent areas than on the previous day. The large vesicles in the dome are about 2 cm. in diameter.

Fig. 5. A view of a urinary bladder demonstrating the large vesicles and a hemorrhagic cystitis. (Courtesy of Dr. Walter Putschar, Charleston West Virginia.)

become quite hard and then cut the blocks. Otherwise the vesicles collapsed and could not be found. The vesicles consist of the connective tissue of the bladder wall. Due to liberation of gas this tissue balloons up, stretching the overlying mucosa and neighboring blood vessels which may rupture and help bring about a hemorrhagic cystitis. The gas present in the vesicles was shown by Lund, Zingale and O'Dowd[4] to be carbon dioxide. It is produced by the action of Escherichia coli organisms on the carbohydrates in the body fluids. Gillies and Flocks[3] described a case of spontaneous renal and perirenal emphysema, with air arranged in a radial manner between the tubules in a diabetic. No gas was made out in the pelves or calyces. There was considerable gas under the capsule. Cultures obtained from the right kidney at surgery gave growths of Escherichia coli. No mention was made of air in the urinary bladder wall. There is no case reported as yet with both the kidneys and bladder involved. Faingold, Hansen, and Rigler[2] have emphasized the transient nature of the condition. The bubbles of gas disappear from day to day and this may account for the small number of cases reported.

SUMMARY

A case of cystitis emphysematosa is presented demonstrating the gas within the bladder wall. It is felt that this condition is more common than originally believed and that the radiologist is in an excellent position to demonstrate it.

Paul Francke, Jr., M.D.
310 Medical Arts Building
Charleston, West Virginia

REFERENCES

1. Eisenlohr, W. Das interstitielle Vagina-Darm- und Harnblasenemphysem zurückgeführt auf gasentwickelnde Bakterien. *Beitr. z. path. Anat. u. z. allg. Path.*, 1888, *3*, 101–156.
2. Faingold, J. E., Hansen, C. O., and Rigler, L. G. Cystitis emphysematosa; review of literature and report of four cases diagnosed by roentgen examination. *Radiology*, 1953, *61*, 346–354.

3. GILLIES, C. L., and FLOCKS, R. Spontaneous renal and perirenal emphysema; report of case in diabetic from Escherichia coli infection. AM. J. ROENTGENOL. & RAD. THERAPY, 1941, *46*, 173–174.

4. LUND, H. G., ZINGALE, F. G., and O'DOWD, J. A. Cystitis emphysematosa; report of case found at cystoscopy and followed by recovery. *J. Urol.*, 1939, *42*, 684–688.

5. MILLS, R. G. Cystitis emphysematosa: I. Report of cases in men. *J. Urol.*, 1930, *23*, 289–306. Cystitis emphysematosa: II. Report of series of cases in women. *J.A.M.A.* 1930, *94*, 321–326. Cystitis emphysematosa: III. Report of an additional case in man, associated with cystitis cystica. *J. Urol.*, 1930, *24*, 217–231. Cystitis emphysematosa: IV. Report of three additional cases in women. *Surg., Gynec. & Obst.*, 1930, *51*, 545–551. Cystitis emphysematosa: V. Case in woman in which trauma appeared to be etiologic factor. *Am. J. Obst. & Gynec.*, 1930, *20*, 688–698.

6. PACKARD, D. R., BEAZLIE, F. S., JR., and CREECY, A. A. Cystitis emphysematosa in diabetic diagnosed at cystoscopy. *Virginia M. Monthly* 1953, *80*, 557–559.

7. RAVICH, A., and KATZEN, P. Cystitis emphysematosa; review of literature with report of an authentic case terminating in recovery. *J.A.M.A.*, 1932, *98*, 1256–1259.

8. SANES, S., and DOROSHOW, G. D. Cystitis emphysematosa. (1) In elderly diabetic women; (2) in three months old infant. *J. Urol.*, 1934, *32*, 278–286.

9. WHEELER, L. D. Cystitis emphysematosa; case report. *J. Urol.*, 1954, *71*, 43–38.

CARCINOMA IN A URINARY BLADDER DIVERTICULUM*

REPORT OF A CASE AND A BRIEF REVIEW OF THE LITERATURE

By SULABHA CHANDRACHUD, M.D.†

BOMBAY, INDIA

THE development of a neoplasm in a urinary bladder diverticulum is not rare. Yet there is usually scant reference to this condition in the standard texts, or inadequate emphasis. Campbell[4] states that diverticula are rarely the site of malignant tumors in adults. Braasch and Emmett[3] show illustrations of such a lesion and point out the complications which may occur.

The classic article on this subject in the early part of the last decade, was written by Abeshouse and Goldstein[1] in 1943. They reported 4 of their own personally observed cases and in a review of the urologic literature up to that time, found approximately 100 other cases. They claimed an over-all incidence of 2.9 per cent of tumors arising in bladder diverticula. Scattered case reports followed this article: by Muellner[8] in 1946, Madison[6] in 1948, Perlman and Bobbitt[10] in 1948, Thomas and Abernathy[12] in 1952 and Ney and Adlerman[9] in 1953.

From the Mayo Clinic, Boylan, Green and McDonald[2] in 1951, reported a series of 25 cases of tumors arising in bladder diverticula over a period of fifty-four years. Mayer and Moore[7] in 1954, claimed that there were approximately 150 cases reported up to that date and added 8 more of their own. Schinz *et al.*[11] make no mention of this condition in *Roentgen-Diagnostics*. Sussman's article in Golden's *Diagnostic Roentgenology*[5] states that neoplasms have been found in diverticula only rarely. It is therefore felt worthwhile to emphasize the fact that such neoplasms do occur. The role of the radiologist in alerting the clinician to this diagnostic possibility is an important one.

REPORT OF CASE

E.F. This was the first Montefiore Hospital admission on July 7, 1954, of an eighty-five year old white male who entered with the chief complaint of urinary bleeding of two years' duration. Seven years before admission the patient underwent a transurethral resection for prostatic hypertrophy and urinary obstruction in another hospital. He did well until two years before admission when he developed intermittent hematuria. Three months prior to admission he had a massive hematuria for which he received three blood transfusions and general supportive therapy which continued until the time of entrance into the hospital.

The physical examination on admission was not remarkable except for the usual changes of advanced age. The laboratory findings consisted of a mild secondary anemia, a blood urea nitrogen of 38.2 mg. per cent and a urine containing 3 plus albumin with the urinary sediment showing many red blood cells and white blood cells.

While in the hospital, intravenous urography attempted with urokon failed to visualize either upper urinary tract. A cystoscopy performed on July 23, 1954, showed the prostatic urethra markedly irregular with several points of oozing. The bladder was seen to be markedly trabeculated and a large mass was noted arising in the left lateral portion of the trigone. A large-mouthed diverticulum was noted on the left lateral urinary bladder wall. The mass was biopsied and the pathologic report was "squamous cell carcinoma of the bladder." Cystoscopy was repeated on July 26, 1954, with the findings the same as those on the previous examination.

A retrograde cystogram done on July 26, 1954, showed a large ovoid sac measuring about 13 by 7 cm. filled with opaque material in the left lateral wall of the urinary bladder.

* From the Division of Diagnostic Radiology, Montefiore Hospital, New York, New York.
† Resident in Radiology under Visitors' Exchange Program (#P-530), Montefiore, Hospital, New York, New York.

Extensive filling defects occupied almost the entire contour of this sac (Fig. 1 and 2). The urinary bladder proper showed irregularity of contour suggesting trabeculations. A roentgenographic diagnosis of a neoplasm in a bladder diverticulum was suggested.

On August 4, 1954, a third cystoscopic examination was done confirming the roentgenographic impression of a neoplasm in a bladder diverticulum.

On August 18, 1954, a right uretero-cutaneous transplant operation was performed. The patient did poorly following this surgical procedure with a gradually rising blood urea nitrogen and blood creatinine. On 8-30-54 a left ureterostomy in situ was done as an emergency procedure but to no avail. The patient's condition gradually deteriorated with a terminal blood urea nitrogen of 110 mg. per cent and a blood creatinine of 9 mg. per cent. He died on September 5, 1954.

Autopsy Findings: (Confined in this paper only to the urinary bladder region). The urinary bladder was enlarged with a greatly thickened wall. It was remarkably trabeculated and contained a huge diverticulum arising from its left posterior wall. Growing within this diverticulum was noted a huge, fungating necrotic mass of whitish tumor tissue which seemed to spill out of the diverticulum and onto the area of the trigone (Fig. 3). The mucosa of the bladder was very hemorrhagic and injected. No definite prostatic tissue could be identified but the tumor tissue had invaded the site where prostate would normally be expected. There were numerous periprostatic lymph nodes which were enlarged, firm and full of whitish tumor tissue.

The microscopic sections of the tumor mass in the bladder diverticulum showed "masses and sheets of squamous epithelial cells with a moderate amount of eosinophilic vacuolated cytoplasm and large irregular vesicular nuclei with nucleoli and mitotic figures. Many epithelial pearls were noted" (Fig. 4). Some necrosis and hemorrhage were also seen. The micro-

FIG. 1. Oblique view of contrast medium filled urinary bladder and diverticulum with radiolucent defect in diverticulum.

FIG. 2. Partially emptied urinary bladder and diverticulum with large filling defect visible in diverticular sac.

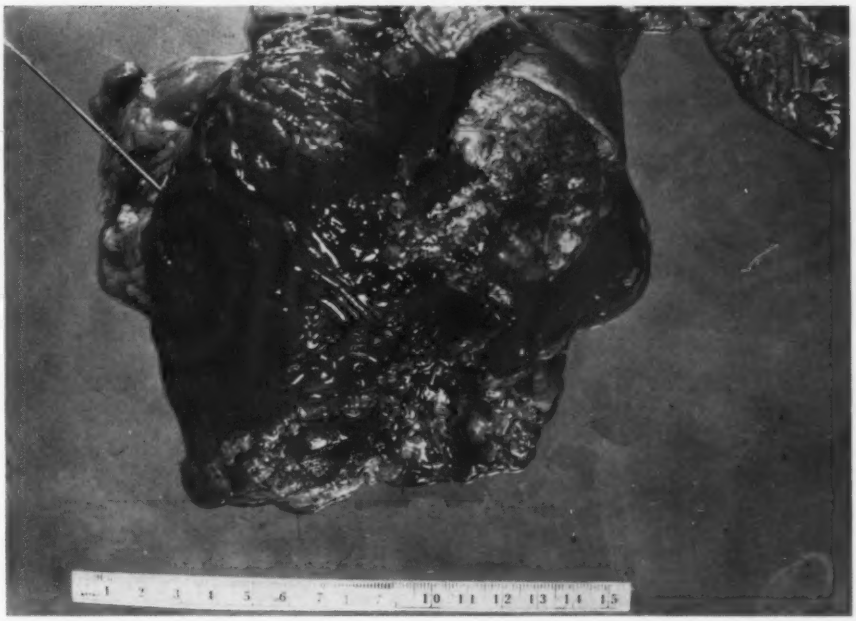


Fig. 3. Gross specimen of diverticulum in urinary bladder containing large tumor mass.

scopic diagnosis was squamous cell carcinoma. Metastatic lesions were found in the liver, the prostate and the body of L 5.

DISCUSSION

The age incidence for tumors in urinary bladder diverticula is mostly that observed in straight-forward neoplasms of the bladder (generally between forty-five to sixty-five years) with a sex preponderance of about 30 to 1 of male to female. The neoplasm is generally malignant with benign tumors reported only about once in every 7 cases

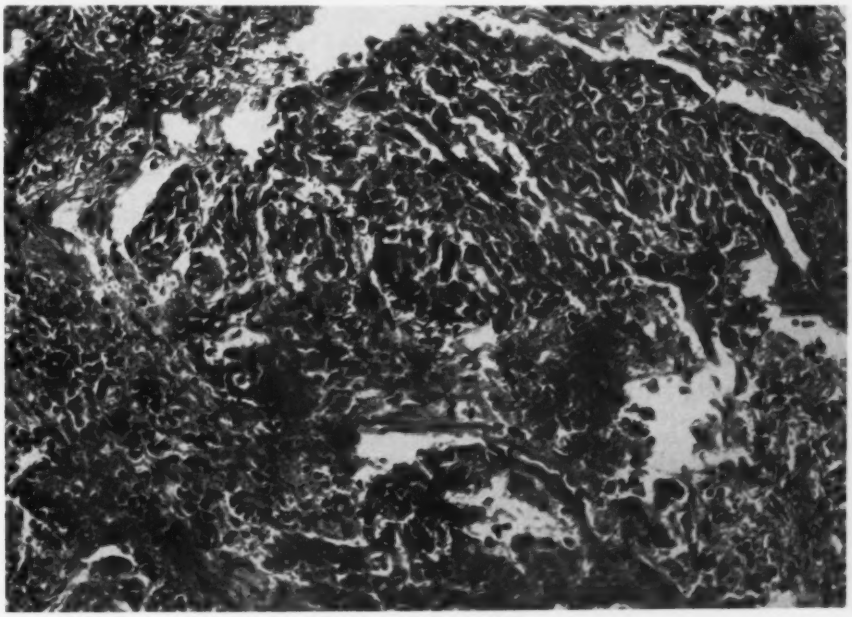


Fig. 4. Microscopic section from specimen in diverticulum showing squamous cell carcinoma.

The most common benign tumor is papilloma while the large majority of the malignant tumors are carcinomas. In the series by Abeshouse and Goldstein,[1] squamous cell epitheliomas were preponderant, while in the series by Boylan, *et al.*,[2] transitional cell carcinomas comprised 67 per cent of the group with adenocarcinoma showing an incidence of 40 per cent and squamous cell carcinomas 25 per cent. An occasional sarcoma has been reported (Thomas and Abernathy[12]). The neoplastic changes may be metaplastic in nature and may be initiated by infection, obstruction, leukoplakia or cystitis. The types of metastases are similar to those which occur in other bladder carcinomas.

There is no pathognomonic symptom complex associated with this condition. The outstanding clinical sign is hematuria, which is generally painless and intermittent in character. Other urinary symptoms such as frequency, nocturia, dysuria, burning, etc., have been reported. Residual urine in the diverticulum in amounts of 20–100 cc. is frequently found. If the tumor is sufficiently large, a mass may be palpable on abdominal and rectal examination.

The diagnosis may be suggested preoperatively by both cystoscopy and cystography, with a confirmatory biopsy sometimes possible at cystoscopy. In the series of Boylan, *et al.*[2] 19 of the 25 reported cases were diagnosed preoperatively while in the series by Abeshouse and Goldstein,[1] only one-third of the cases was diagnosed before operation. In the case herein described, the roentgen diagnosis was suggested on cystography and then confirmed by cystoscopic examination.

A filling defect in a urinary bladder diverticulum should always suggest the possibility of a neoplasm. Differential confusing lesions are calculi or blood clots. Cystoscopy should be done with films taken in the frontal, oblique and lateral projections. At times, the diverticulum may not be filled for mechanical reasons because of the presence of blood clots. Occasionally, the diverticulum may be covered by the overlapping urinary bladder, but oblique and/or lateral views generally will demonstrate the sac.

The diagnosis may be made on cystoscopy if the diverticulum is identified and if the tumor is seen by direct inspection, particularly if the diverticular neck is sufficiently large. The diagnosis may be suggested by observing the escape of blood from the orifice of the diverticulum. At times, tumor tissue may be seen to protrude from the diverticular orifice itself through the cystoscope.

Perlman and Bobbitt[10] feel that the incidence of neoplasm in bladder diverticula is probably higher than generally thought. They suggest excision of all urinary bladder diverticula in order to obviate the development of carcinoma. Certainly in those cases of a demonstrated bladder diverticulum where hematuria occurs, the possibility of a carcinoma in the sac should be considered and diligently searched for.

SUMMARY AND CONCLUSION

A case of squamous cell carcinoma in a large urinary bladder diverticulum is reported.

A brief résumé of the literature concerning this subject is given. The incidence, symptoms, signs, diagnosis and differential diagnostic possibilities are briefly described.

The problem of prophylactic surgery for bladder diverticulum and the role of the radiologist in the diagnosis are emphasized.

Montefiore Hospital
210th St. & Bainbridge Ave.
New York 67, New York

REFERENCES

1. ABESHOUSE, B. S., and GOLDSTEIN, A. E. Primary carcinoma in diverticulum of bladder; report of four cases and review of literature. *J. Urol.*, 1943 *49*, 534–557.
2. BOYLAN, R. N., GREENE, L., and MCDONALD, J. R. Epithelial neoplasms arising in diverticula of urinary bladder. *J. Urol.*, 1951, *65* 1041–1049.
3. BRAASCH, W. F., and EMMETT, J. L. Clinical Urography: An Atlas and Textbook of

Roentgenologic Diagnosis. W. B. Saunders Company, Philadelphia, 1951, pp. 202, 492–494.

4. Campbell, M. F. Urology. Vol. I. W. B. Saunders Company, Philadelphia, 1954, pp. 375.
5. Golden, R. Diagnostic Roentgenology. Section by M. L. Sussman. Williams & Wilkins Company, Baltimore, 1948, pp. 708.
6. Madison, B. B. Papillary carcinoma of bladder diverticulum treated by transurethral resection. *J. Urol.*, 1948, *59*, 42–43.
7. Mayer, R. F., and Moore, T. D. Carcinoma complicating vesical diverticulum. *J. Urol.*, 1954, *71*, 307–315.
8. Muellner, S. R. Cancer in diverticulum: Pitfall to resectionist. *J. Urol.*, 1946, *56*, 427–428.
9. Ney, C., and Adlerman, E. J. Calculus and primary carcinoma in diverticulum of bladder; case report and review of literature. *New York State J. Med.*, 1953, *53*, part II, 1782–1784.
10. Perlman, C. K., and Bobbitt, R. M. Carcinoma within diverticulum of bladder. *J. Urol.*, 1948, *59*, 1127–1129.
11. Schinz, H. R., Baensch, W. E., Friedl, E., and Uehlinger, E. Roentgen Diagnostics. Vol. IV. Grune & Stratton, New York, 1954.
12. Thomas, E. M., and Abernathy, E. L. Leiomyosarcoma in diverticulum of bladder. *J. Urol.*, 1952, *68*, 470–474.

VERTEBRAL METASTASIS IN RENAL CARCINOMA*

AN ANATOMIC CORRELATION

By GEORGE T. WOHL, M.D.†

PHILADELPHIA, PENNSYLVANIA

THE spine is a frequent site of localization of metastasis in renal carcinoma. A review of the literature indicates that much anatomic information is now at hand showing a close integration of the renal venous drainage and the venous drainage of the spine by way of the vertebral plexus of veins. A mechanical explanation is thus possible to explain the frequency of this type of metastatic spread. Four cases of left renal carcinoma recently studied in our institution are presented to illustrate this type of metastatic spread to the spine, corroborating the importance of the venous route in such metastasis.

REPORT OF CASES

Case 1. Register no. 157. (Fig. 1.) The patient was a fifty-six year old white male admitted in January, 1953, with a history of severe back pain of six months' duration. Review of transfer records from another institution indicated that four months prior to admission to our hospital, a roentgen study demonstrated an osteolytic lesion of the right transverse process and a portion of the body of the fifth lumbar vertebra There was also a lytic lesion in the body of the second lumbar vertebra (Fig. 1).

An exploratory operation on September 19, 1952, revealed an osteolytic lesion of the spine. Pathologic examination of the biopsy material was performed and a diagnosis of "metastatic carcinoma of bone; probably from kidney or prostate" was rendered. An intravenous urogram revealed a large mass in the left kidney. A left nephrectomy was done with a pathologic diagnosis of "renal carcinoma of the dark and clear cell type." Two hundred kilovolt roentgen-ray treatment to the involved lumbar vertebrae was given in full dosage. However, little effect from the radiation was obtained and the patient was admitted to our institution after developing intractable pain in the back radiating down the right leg. Physical examination on admission revealed a chronically ill patient in moderate distress from back pain. Head, neck, nose, throat and chest were negative. Abdomen was normal. Laboratory study revealed a mild anemia but was otherwise normal.

Roentgen examination soon after admission showed several soft zones of infiltration in the left midlung thought at the time to represent metastatic spread into the left lung. Examination of the thoracic spine showed evidence of an osteolytic metastasis in the fourth thoracic vertebral body with partial collapse of this vertebra. Examination of the lumbar spine and

Fig. 1. Case 1. A. T. Intravenous urogram (Sept. 29, 1952) showing: (1) large tumor of the lower pole of the left kidney; (2) osteolytic lesion of the body of the second lumbar vertebra; and (3) an osteolytic lesion of the body and transverse process of the fifth lumbar vertebra.

* From the Veterans Administration Hospital, Philadelphia, Pennsylvania.
† Chief, Department of Radiology, Veterans Administration Hospital, Philadelphia, Pennsylvania.

pelvis demonstrated an osteolytic lesion involving the left half of the body of the second lumbar vertebra with partial collapse of this body. There was also marked destruction of the entire right third of the fifth lumbar vertebral body and spread into the adjacent pelvis in the region of the superior aspect of the right sacroiliac joint. Patient received additional roentgen therapy without significant effect. No further treatment could be offered and patient was transferred to a nursing home. He subsequently expired.

Diagnosis: Renal carcinoma of the dark and clear cell type with metastases to the dorsal spine, lumbar spine, pelvis, and lungs.

Case II. E.Y. Register no. 2256. (Fig. 2.) The patient was a forty year old white male who entered our hospital complaining of severe pain in the left flank, accompanied by nausea and vomiting. The present illness dated back to June, 1951, at which time following a bout of chills, fever, and left flank swelling, patient was hospitalized in another institution. Following diagnosis by the usual methods, a left nephrectomy was performed. A large tumor of the lower pole of the left kidney was found, diagnosed histologically as clear cell carcinoma. The roentgen study of the spine and pelvis, as well as lungs, was negative at that time. Following surgery he received radiation therapy to the left renal area through anterior and posterior ports to a total tumor dose of approximately 2,500 roentgens. The patient was discharged and did well until six weeks prior to admission to our hospital in August, 1953. At that time, he began having constant pain in the left flank in the region of the old incision. The pain became progressively worse and the family physician had to resort to frequent use of narcotics. Physical examination was non-contributory. Laboratory studies were negative. Roentgen study of the chest demonstrated five large metastatic foci in the right lung and one large metastatic foci in the left lung. Examination of the spine was negative except for the presence of a dense sclerosis of the entire body of the twelfth thoracic vertebra. No collapse was present (Fig. 2). This was considered a metastatic lesion from a primary left renal tumor. The patient received roentgen therapy to the involved vertebral body with some temporary relief of symptoms. Following completion of therapy patient was discharged to be followed on an out-patient basis. Pain again developed and he was re-admitted two months after original discharge. The pulmonary lesions had shown much progression. The lesion in the twelfth thoracic vertebra remained unchanged. In addition, at this time masses were palpable in the left lower abdomen. Patient was given cobra venom with some relief and discharged for nursing care.

Fig. 2. Case II. E. Y. Note dense sclerosis of the body of the twelfth thoracic vertebra on basis of osteoblastic metastasis from primary left renal carcinoma removed two years prior to this study.

Pathologic examination of kidney: 1. Gross: Specimen measured 26×17×8 cm. and consisted of kidney and large bloody yellowish friable tumor mass; 2. Microscopic: Sections showed a typical clear cell carcinoma of the kidney which was accompanied by marked retrogressive changes, necrosis and hemorrhage. The kidney parenchyma showed inspissated proteinous material in some of the tubules and some tubules contained red blood cells.

Diagnosis: Clear cell carcinoma of the left kidney, with metastases to the twelfth thoracic vertebra, lungs and abdomen.

Case III. J.M. Register no. 856. (Fig. 3.) A fifty-seven year old white male admitted April 15, 1953, with a history of low back pain of two weeks' duration. About twenty-four hours before admission, patient developed pain in the ab-

Fig. 3. Case III. J. M. Note osteolytic lesion of the body of the first lumbar vertebra with partial collapse of this vertebra.

domen and genitalia. The pain did not radiate down the legs, nor was there hematuria or dysuria. Past medical history was non-contributory. Physical examination was essentially negative except for findings referable to the back. The lumbar spine was completely straight and spastic. Neurologic examination elicited findings of early left lower monoplegia.

Roentgen examination on admission demonstrated an osteolytic lesion of the body of the first lumbar vertebra with partial collapse of this vertebra (Fig. 3). The rest of the dorsolumbar spine was negative. Numerous metastatic foci were present in the chest. A subsequent intravenous urogram showed evidence of a large tumor mass of the left kidney. Examination two months after admission revealed metastases in the bodies of the first and second lumbar vertebrae. The subsequent course was progressively down-hill and patient expired three months after admission.

Postmortem examination was performed with the following pertinent findings noted: There was marked cachexia. The lungs contained numerous large and small metastatic foci. Bilateral pleural effusion was present.

Genitourinary system: The retroperitoneal supportive tissue and the kidney formed one large mass on the left side. Upon removal of the perirenal tissue it was noted that the fat was extensively infiltrated by the tumor. The involvement was also continuous on the left with the tumor which involved the first lumbar vertebra. Sections through the perirenal nodular involvement were gray and firm with areas of necrosis which were pale yellow. The left kidney weighed 500 grams. There was a large spherical tumor present at the upper pole. The outer surface was nodular and the sectioned surfaces revealed multiple, irregular, roughly circular areas separated by firm bands of fibrous tissue within this main tumor mass. Some of these were gray and firm. Others were necrotic

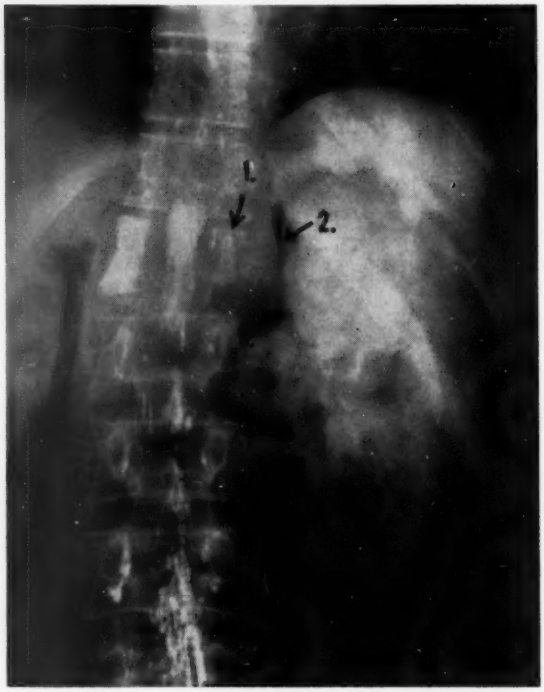


Fig. 4. Case IV. Pre-sacral air study showing: (1) osteolytic lesion of first lumbar vertebra; (2) tumor mass surrounding first lumbar vertebra; (3) deformity of superior pole of left kidney due to tumor.

and pale yellow, while still others showed dark red mottling. The tumor mass measured 9 cm. in diameter. Smaller secondary nodules were present involving the lower pole of the kidney. These were homogenously firm and gray and mainly superficial. The capsule was firmly adherent at the site of involvement. The right kidney weighed 150 grams and was essentially normal. The pelves and ureters revealed no abnormality. The arteries were not remarkable. The veins on the left side revealed no evidence of tumor invasion.

Vertebrae: A cuff of tumor consisting of gray tissue surrounded the first lumbar vertebra, which having been destroyed had collapsed. On section this vertebra revealed gray and white surfaces with fine trabeculae of bone. The involvement extended caudad to involve L-2 and cephalad to involve T-12.

Microscopic findings: The histologic sections through the kidney tumor revealed cords and trabeculae of compactly arranged cells having a vacuolated cytoplasm and relatively small hyperchromatic, centrally placed nuclei. In areas, fine vascular channels separated these trabeculae or tumor cells. In other areas, bands or cords or fibrous tissue were present. Infrequent masses of tumor cells had a granular, darker staining cytoplasm. The tumor cells showed areas of necrosis. The surrounding kidney parenchyma showed evidence of compression with fibrosis. The tumor extended into the peripelvic region of the kidney. A mixture of the two types of cells was seen in the metastatic deposits with a greater tendency towards pleormorphism.

Fig. 5. Case iv. Contrast material (70 per cent urokon) injected through percutaneous lumbar route in course of aortography into body of first lumbar vertebra. Note: (1) contrast medium in tumor mass in body of vertebra; (2) reflux of contrast medium through venous system into region of kidney tumor; (3) ascent of contrast medium in azygos system toward vena cava.

Fig. 6. Case iv. Percutaneous lumbar aortogram showing; (1) aorta; (2) osteolytic metastasis with contrast material "stain" from earlier injection in body of first lumbar vertebra; (3) left renal artery; (4) arterial characteristics of supply of tumor of kidney; (5) pantopaque in spinal canal from earlier myelogram.

Case iv. J.C. Register no. 2178. (Fig. 4, 5 and 6). The patient was a forty-two year old white male admitted August 3, 1953, complaining of severe back pain without radiation dating from November, 1952. Treatment by various physicians was of no avail. Roentgen study of the lower spine on various occasions prior to admission did not disclose abnormal findings. Physical examination on admission was essentially negative except for the oblitera-

tion of the lumbar curve and a right thoracic left lumbar scoliosis. There was pain on bending to the right side, located in an area around the iliac crest. Straight leg raising test on the left side was painful at 60 degrees. Right leg raising was normal.

Roentgen study of the spine on admission demonstrated an osteolytic lesion of the body of the first lumbar vertebra with a partial compression of the left lateral aspect of this vertebral body. Chest examination was negative. In view of the diagnosis of osteolytic metastasis to the spine, intravenous urography was performed. Distortion and "pushing aside" of the superior and middle calyceal system of the left kidney was observed indicative of a mass in the superior pole. There was also an elongation of the middle calyx of this kidney. A lumbar aortography was decided upon for further analysis of the nature of this left renal mass. On the first insertion of the needle, the tip of the needle was noted within the body of the pathologic vertebra. Contrast material was injected and subsequent films showed it spread diffusely throughout this vertebral body (Fig. 5). Some retention of the medium in the vertebral body occurred on the serial films. However, and of importance to this discussion, there was a definite reflux of the contrast medium from this involved vertebral body through venous channels into the region of the superior pole of the left kidney. Part of the contrast medium ascended into the thorax, apparently through the azygos system (Fig. 5). The tip of the needle was then moved and placed in the aorta. A second injection of the opaque medium (70 per cent urokon) was made and an excellent aortogram obtained (Fig. 6).

This study demonstrated quite well the typical pooling and gross vascular changes in the left renal vessels supplying the tumor mass. The vascular changes were considered diagnostic of malignant tumor of the kidney. Figure 4 is a pre-sacral air study demonstrating both the tumor mass surrounding the first lumbar vertebra and the actual tumor distorting the contour of the kidney.

It is interesting that urinalysis was negative at all times and no blood or other abnormal findings were noted in the urine specimens.

The patient was operated on under general anesthesia, using the usual posterior approach. The left kidney was identified but considerable difficulty was encountered in mobilizing it because of the presence of a large tumor thrombus in one of the left renal veins. The renal vein containing the thrombus was carefully isolated, clamped and sewn. Then a nephrectomy was performed.

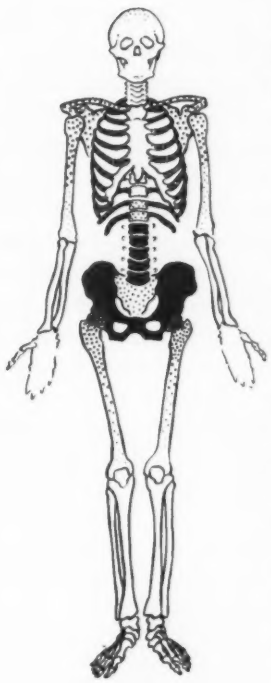
The pathologic findings were as follows: Gross: The specimen consisted of a kidney measuring 12×5×5 cm. Along the posterior hilar region there was a node distorting the usual contour of the kidney, which on section showed a tumor mass measuring 3.5 cm. in diameter. Sections through the tumor revealed irregular areas of yellowish gray nodules intermingled with irregular red areas. The tumor encroached upon the hilar region which was infiltrated grossly. There was tumor within several of the vascular channels. The rest of the kidney parenchyma was not remarkable. The capsular surface was smooth. There was a segment of adrenal attached to the specimen. Microscopic: Histologic sections revealed irregular collections of neoplastic cells, some of which were arranged in compact nests of pleomorphic cells having abundant clear cytoplasm with relatively clear nuclei. In other areas the tumor cells were separated by fine strands of partially hyalinized collagenous tissue while in still others the tumor cells showed attempted tubule formation. In two sections invasion of the vascular wall by the tumor cells could be seen. The tumor also invaded the adrenal gland.

The patient received roentgen therapy for a total tumor dose of 2,880 roentgens to the first lumbar vertebral body using 250 kv. No significant effect was obtained from the irradiation.

Diagnosis: clear cell carcinoma of left kidney with vascular invasion.

DISCUSSION

The frequency of metastasis to the spine and pelvis from primary renal carcinoma is emphasized by the study of Fried.[8] This author, in analyzing 87 cases of malignant tumors of the kidney, found that 45 per cent showed skeletal metastases. Thirty-eight per cent of these metastases were to the spine, and another 46 per cent were to the pelvis (Fig. 7). We have presented a group of 4 cases of left renal carcinoma in which the early spread was to the thoracolumbar spine. Study of this group of cases suggests a common mechanism for this type of



MALIGNANT TUMORS OF THE KIDNEY

NUMBER OF CASES 87

CASES WITH SKELETAL METASTASES 39-45%

ANATOMICAL DISTRIBUTION

LOCALIZATION			No. of CASES	PERCENT
PELVIS			18	46
SPINE	CERVICAL	1	15	38
	DORSAL	8		
	LUMBAR	13		
	SACRAL	4		
FEMUR			14	36
RIBS			13	33
SCAPULA			9	23
CLAVICLE			7	18
SKULL			6	15
HUMERUS			5	13

1. THE METASTASES WERE GENERALLY MULTIPLE.
2. IN 17 CASES (43%) THE METASTASES WERE CONFINED TO A SINGLE BONE.
3. TYPE
   A. OSTEOCLASTIC, OCCASIONALLY WITH CYSTIC CHANGES.
   B. OSTEOBLASTIC CHANGES ALSO OCCASIONALLY PRESENT.

FIG. 7. Skeletal metastasis in malignant tumors of kidney. (Reproduced by permission from Fried.)

metastases. The known anatomy of the venous circulation with its close integration with the vertebral plexus of veins offers an explanation for the mechanism. Instructive in this respect is our last case which actually demonstrates by means of contrast medium injected into the involved vertebral body, venous reflux into the tumor mass in the kidney.

The anatomy of the pararenal system of veins in man was subject to careful study by Anson and co-workers[1,2] as well as others. They point out that the pattern of veins draining the kidneys does not closely match that of the arteries of supply, and that further there is a marked difference between the venous drainage of the left and of the right kidneys. They found the left renal vein to have lumbar, or hemiazygos communications in about 70 per cent of cases. The right renal vein, on the contrary, does not possess such communications. Furthermore, the left gonadal vein always joins the renal vein—an arrangement that is not common on the right side.

The suprarenal vein receives capsular tributaries as well as the inferior phrenic vein and on the left frequently joins the main left renal vein. The left renal vein in itself is quite complex, not only in respect to the arrangement of its tributary system but also in regard to its pattern of division and anastomosis. The scheme of lumbar drainage varies widely but there is a tend-

ency towards concentration of the tributaries towards the renal level with numerous variations of pattern observed.

Under conditions of occlusion of the main renal vein by tumor thrombus formation, a condition that not infrequently occurs, an extensive venous collateral drainage from the kidney develops (Case IV). In such instances, two sets of venous channels usually show enlargement. These are the ureteric veins and the subcapsular-capsular veins. The ureteric veins terminate in the vesicular veins in the pelvis, and by this route into the hypogastric vein. The major drainage of the subcapsular veins under these conditions of obstruction of the main renal vein is into the gonadal vein, the ureteric vein, and lumbar veins. Above the kidney they empty into the adrenolumbar vein and medially into the patent segment of the renal vein. In any case, here as elsewhere, the general tendency of the venous blood is to return to the vena cava by the most direct route. This rich integration of the renal vein with the vertebral plexus, and the veins draining the lumbar vertebrae and pelvis is well demonstrated by Figure 8. Batson[3,4] has shown experimentally that when there is an increase in intrathoracic pressure as occurs in the Valsalva maneuver there may be a reflux of blood in a retrograde fashion into points of origin of such venous blood. It is easy to understand how, under such conditions, tumor emboli from the kidney may readily be deposited in the spine and pelvis. Considering the known tendency of renal carcinomas to invade the venous system such tumor emboli must be frequent. As Coman[5] notes in a review of the mechanisms responsible for the origin and distribution of blood-borne tumor metastases, it is now well established that

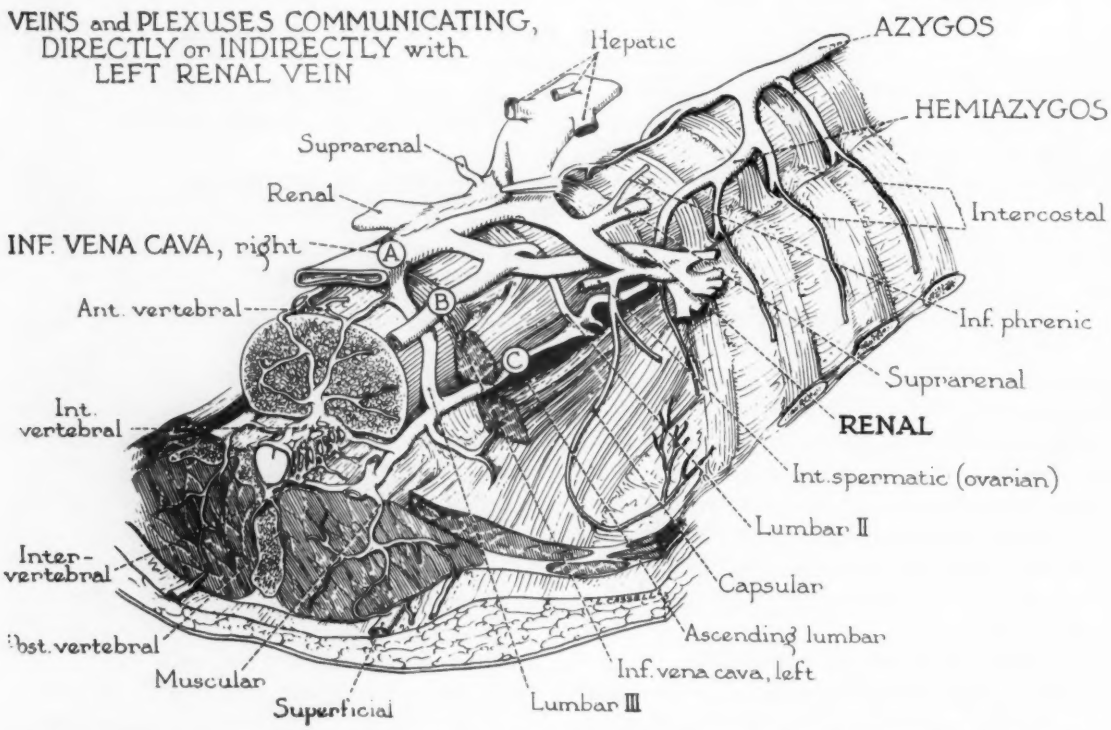


Fig. 8. Veins of dorsum of trunk at renal level. Semidiagrammatic composite of three specimens. On right, suprarenal and renal veins empty directly into the inferior vena cava (at *A* in approximately median position upon vertebral column). On left, communicating directly or indirectly with pre-aortic or post-aortic limb of circum-aortic venous ring are the following: left inferior vena cava (*B*) in sulcus between vertebral bodies and ventral margin of left psoas muscle; ascending lumbar vein (*C*), coursing deep to substance of psoas muscle; hemiazygos vein and its intercostal tributaries; inferior phrenic and suprarenal veins; capsular veins; etc. (Reproduced by permission from Anson and Cauldwell[2].)

the invasiveness of the cancer cell depends largely upon a loss of adhesiveness. This loss is in turn associated with local calcium deficiency. The cancer cell thus becomes a free living detached unit. In renal carcinoma the detached cancer cell may readily pass by venous channels both into the vertebral system and into the general venous return. The mechanics of circulation as such indicate a probability of venous spread of metastatic emboli similar to that seen in clinical practice. Hence, one would anticipate the frequency of metastases in those parts drained by the vertebral plexus—the spine, pelvis and skull, as well as a general distribution to the lungs, and other distant parts. While the above offers an explanation of the mechanics of lodgment of tumor emboli, the subtle cause of growth in such "soil" remains yet to be more fully amplified.

SUMMARY

The axial skeleton is a frequent site of early metastases from primary renal carcinoma. Four cases demonstrating such spread have been presented. It is believed that the mechanics of venous circulation afford an explanation for the frequency of this localization.

The anatomy of the renal venous system and its close integration with the vertebral plexus has been reviewed and used as a basis for explanation of this route of dissemination of carcinoma of the kidney.

Department of Radiology
Veterans Administration Hospital
Philadelphia 4, Pennsylvania

REFERENCES

1. Anson, B. J., Cauldwell, E. W., Pick, J. W., and Beaton, L. E. Anatomy of pararenal system of veins with comments on renal arteries. *J. Urol.*, 1948, *60*, 714–737.
2. Anson, B. J., and Cauldwell, E. W. Pararenal vascular system; study of 425 anatomical specimens. *Quart. Bull. Northwestern Univ. M. School*, 1947, *21*, 320–328.
3. Batson, O. V. Function of vertebral veins and their role in spread of metastases. *Ann. Surg.*, 1940, *112*, 138–149.
4. Batson, O. V. Role of vertebral veins in metastatic processes. *Ann. Int. Med.*, 1942, *16*, 38–45.
5. Coman, D. R. Mechanisms responsible for origin and distribution of blood-borne tumor metastases: Review. *Cancer Research*, 1953, *13*, 397–404.
6. Dresser, R. Metastatic manifestations of hypernephroma in bone. Am. J. Roentgenol. & Rad. Therapy, 1925, *13*, 342–353.
7. Ewing, J. Neoplastic Diseases. Third edition. W. B. Saunders Company, Philadelphia, 1928, pp. 86.
8. Fried, J. R. Skeletal and pulmonary mestatases from cancer of kidney, prostate and bladder. Am. J. Roentgenol. & Rad. Therapy, 1946, *55*, 153–164.
9. Hollinshead, W. H., and McFarlane, J. A. Collateral venous drainage from kidney, following occlusion of renal vein in dog. *Surg., Gynec. & Obst.*, 1953, *97*, 213–219.
10. Keen, J. A. Collateral venous circulation in case of thrombosis of inferior vena cava and its embryological interpretation. *Brit. J. Surg.*, 1941, *29*, 105–114.
11. McClanahan, C. W., and Bonann, L. J. Signal skeletal metastases from renal carcinoma. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., 1953, *70*, 387–400.
12. McDonald, J. R., and Priestly, J. T. Malignant tumors of kidney; surgical and prognostic significance of tumor thrombosis of renal vein. *Surg., Gynec. & Obst.*, 1943, *77*, 295–306.
13. Turner, J. W., and Jaffe, H. L. Metastatic neoplasms; clinical and roentgenological study of involvement of skeleton and lungs. Am. J. Roentgenol. & Rad. Therapy, 1940, *43*, 479–492.

VERTEBRAL OSTEOMYELITIS FOLLOWING OPERATION ON THE URINARY TRACT OR SIGMOID

THE THIRD LESION OF AN UNCOMMON SYNDROME*

By EDWIN L. LAME, M.D.
PHILADELPHIA, PENNSYLVANIA

NONTUBERCULOUS osteomyelitis of the vertebrae has been thoroughly described, but, in recent years, somewhat neglected. Perhaps this is due to its low incidence. As one reviews its pathogenesis, there are discovered a few strange lesions having most unusual relations.

Among others, we have reported on the pubic-ischial syndrome, osteitis pubis.[23] The evidence indicates to us that osteitis pubis is a low grade osteomyelitis. In our group of 9 cases, 1 had a severe destruction of the hip (Fig. 1). There are published records of 3 other cases.[14,19,31] Thus, from the relatively benign pubic and ischial disease, which never results in permanent disability or death, rarely, a hip lesion arises, which destroys this joint. One case[14] supplied a biopsy and cultures of the hip and urine confirming the theory of pyogenic arthritis and osteomyelitis. The others bear the clinical and roentgen criteria of such a lesion. All have followed closely upon prostatectomy. This material is the sanction for considering the pubic-ischial disease as the first link and the hip disease as the second link in a chain of osteomyelitis.[24]

Recently came to our attention 3 patients having vertebral osteomyelitis, each with an antecedent operation on the urinary system or the rectosigmoid. This group, together with several described in the literature,[1,8,10,13,19] appears to form the third link in a postoperative bone syndrome having its origin in obscure infection, which rarely can be activated by surgical operation.

It is the aim of this discussion to associate these three sites of unusual bone infection, so as to portray a practical and simplified diagnostic and therapeutic picture.

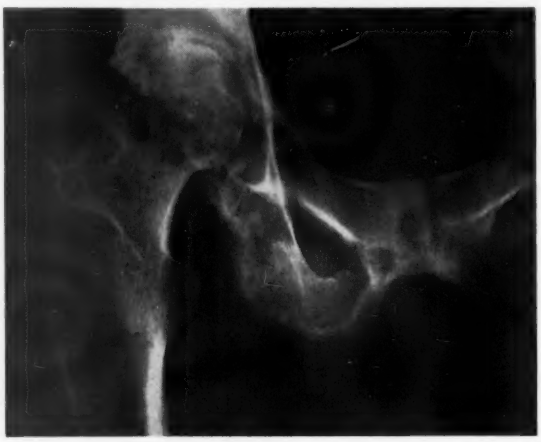


FIG. 1. Probable pyogenic arthritis of the hip following prostatectomy and osteitis pubis in 1 of our 9 cases of the pubic disease. Note the well healed pubes. Hip joint function is severely impaired.

Too often are we confused by excessive analysis of disease and expansion of terminology. Here, it seems there are examples of related lesions presenting in different anatomic locations.

INCIDENCE

Nontuberculous vertebral osteomyelitis comprises 1.5 to 4 per cent of all cases of nontuberculous osteomyelitis. Males are affected more often, especially in the group of urinary tract disease. The age of patients in general extends from childhood to seventy years, with an average of thirty-

* From the Department of Radiology, The Presbyterian Hospital, Philadelphia, Pennsylvania. Presented at the Fifty-fifth Annual Meeting, American Roentgen Ray Society, Washington, D. C., Sept. 21–24, 1954.

five to forty years.[17,20,26] In the group under the present discussion fifty to seventy years is most typical.

GRADES OF SEVERITY

The degree of severity, as in most disease, varies widely from mild to fatal. Unfortunately, this factor has encouraged students to attach multiple names to match the virulence. "Bland osteomyelitis,"[39] "infectious spondylitis,"[15,36] "spondylarthritis"[28] and "chondromalacic spondylosis"[39] designate what appear to be varying grades of old-fashioned osteomyelitis.

ETIOLOGY AND PATHOGENESIS

The classical causes of pyogenic spondylitis are well known: staphylococcus and streptococcus infections of the skin and deeper tissues (abscess, erysipelas, empyema, contagious disease and bone lesions other than of the spine). More unusual agents are the organisms of typhoid, undulant fever and gonorrhea. There is some belief that the urinary system may be the important focus for these bacteria. Least common causes may be grouped in two categories: (1) spinal canal puncture,[34] paravertebral anesthesia[25] and the unexplained events of childhood,[28] and (2) the poorly appreciated organisms inhabiting the urinary or intestinal tract.

The urinary system is very probably infected in most patients having operation on it and in many others being treated for various diseases. Cautery and amputation of penile carcinoma has been followed by fatal meningitis,[3,37] urethroscopy and cystoscopy by bacteriemia.[2,30,32]

When we analyzed the 10 known biopsies secured in cases of osteitis pubis,[23] the organisms were the colon bacillus, proteus, *Staphylococcus aureus* and Pseudomonas (*B. pyocyaneus*). The only case of hip disease biopsied carried Pseudomonas in both hip and urine.[14] In the reported cases of vertebral osteomyelitis following urinary infection or operation on the urinary tract,[1,8,10,13,18,22,29] eight blood or vertebral cultures showed Pseudomonas, Staphylococcus, Streptococcus, and the colon bacillus twice and Proteus once. Six of the 8 patients had the same organism in the urine as in the blood or vertebra. These bacteria are the common organisms of urine found in our hospital. The usual stool culture contains the colon bacillus in large numbers and Salmonella next in order.

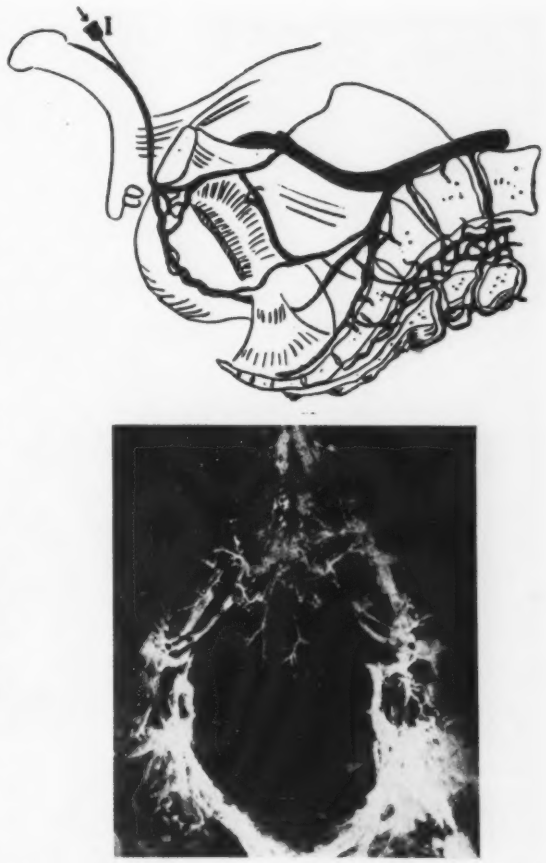


FIG. 2*A*. From the originals of Batson. Diagram and injection specimen demonstrating the venous channels from the deep dorsal vein of the penis to the prostatic, obturator, iliac, sacral and finally the vertebral plexuses. (Reproduced by permission from *Ann. Surg.*, 1940, *112*, 138–149, and *Ann. Int. Med.*, 1942, *16*, 38–45.)

Infections, probably causative, which have preceded the vertebral lesion in 16 cases have been: pyelonephritis 7 times, perinephritis 3 times, prostatitis 3 times[1,8,13,17,18,19,22,29,39] and cystitis once. In

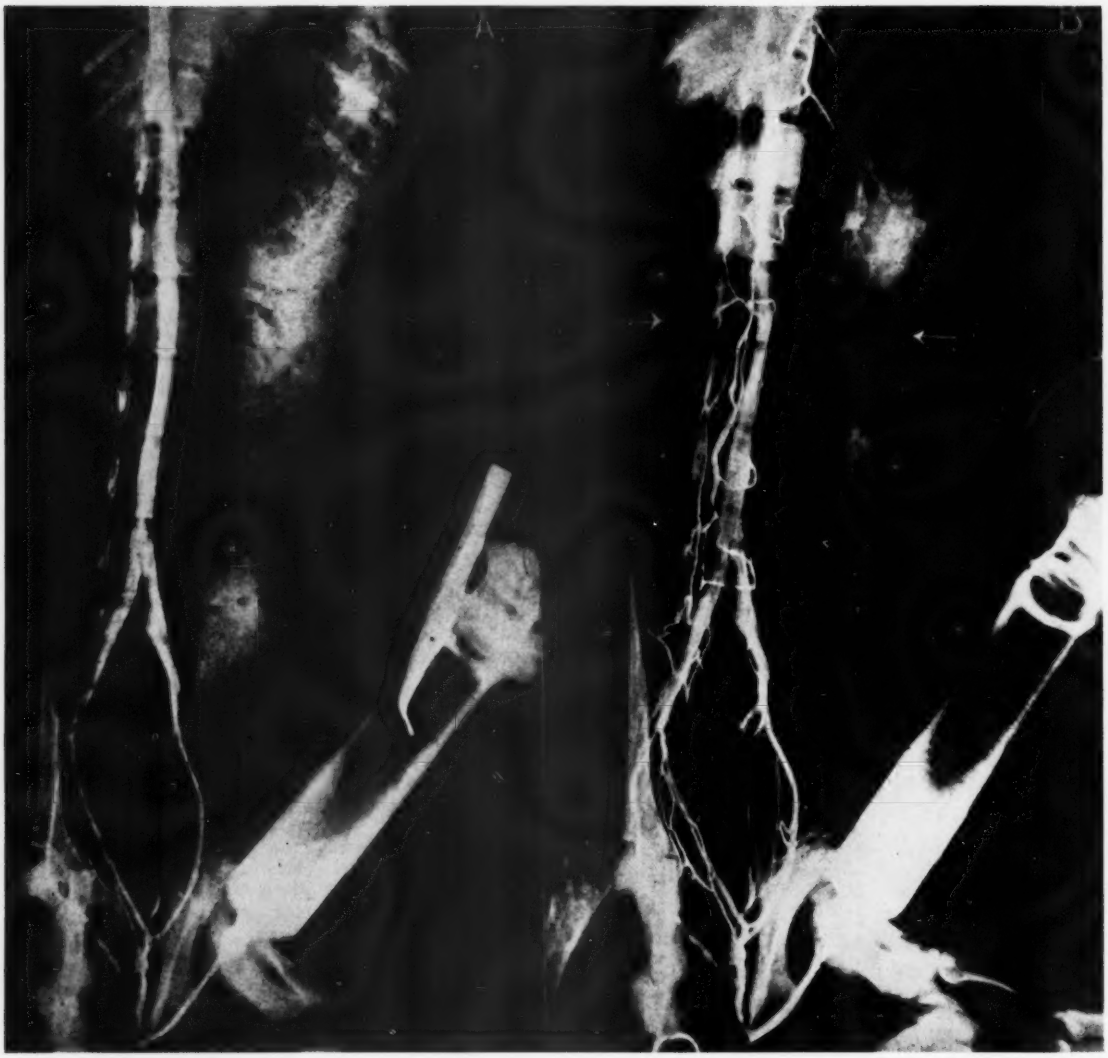


FIG. 2*B*. Similar injection in the monkey, demonstrating flow to the caval system (on the left) and, during increased intra-abdominal pressure, to the caval and vertebral systems (on the right). (Reproduced by permission from *Ann. Surg.*, 1940, *112*, 138–149.)

5 cases, there was no known preoperative infection. Of these, 3 had a probable postoperative infection of the prostatic bed;[10] 1 of ours had severe cystitis postoperatively; and a second had an apparently clean sigmoid operation, perhaps with embolic accident, but without proved etiology.

Eleven *operations* preceded vertebral infection: 4 prostatectomies, 1 incision of prostatic abscess, 2 nephrectomies, 1 pyelotomy, 1 cystotomy,[1,8,10,13,19] 1 sigmoid polypectomy and 1 abdominoperineal resection.

The *spread* of infection from the urinary or pelvic organs is illuminated for us by the history of malignant metastases from the prostate, cervix and uterine fundus to the pelvis, lumbar and dorsal spine. A direct analogy exists in the familiar dissemination of carcinoma of the kidney to vertebrae, ribs, pleura and lung. These mechanisms have been well explained by Batson working with the vertebral veins[4,5] (Fig. 2, *A* and *B*). The instances of cautery of the penile cancers followed by fatal meningitis, known to Widmann and Bat-

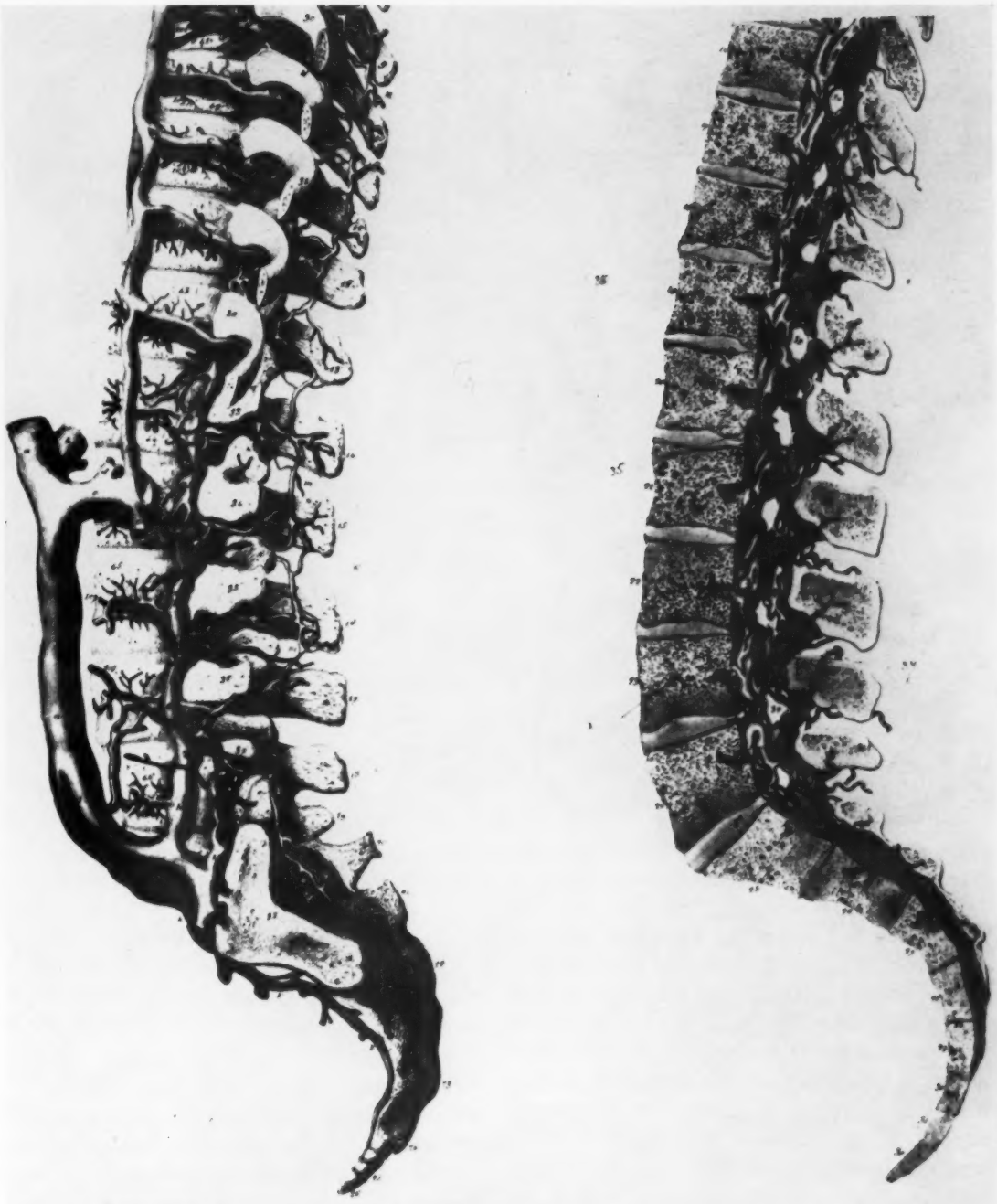


Fig. 3*A*. From Breschet. The caval, vertebral and intercostal veins, inferior group. The blood-reservoir nature of the vertebrae can be appreciated.

son,[3,37] and the bacteriemia following manipulation of the urethra and bladder[2,30,32] serve as strong evidence that bacteria spread rapidly and far from pelvic foci.

The important anatomic works of Breschet (Fig. 3, *A* and *B*), Ribet (Fig. 4, *A* and *B*) and Batson (Fig. 2, *A* and *B*) show clearly that pelvic infection, which has extended from soft tissue to pubis to hip, will

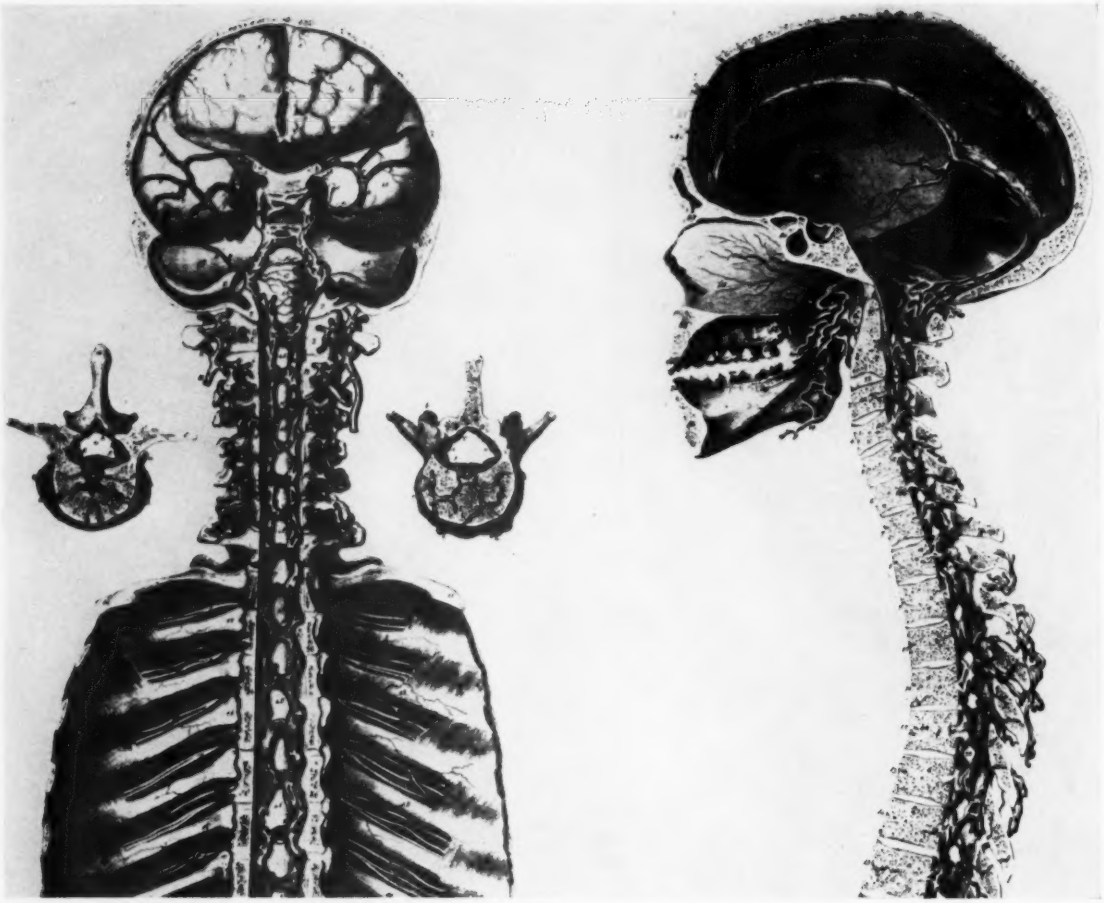


FIG. 3*B*. The superior group showing the paths to the thorax and skull. Osteomyelitis of pelvic origin has occurred in the cervical spine; it may be predicted in the ribs, and the meningitis of old may reappear.

find ready paths to the vertebral column and even beyond. By transpubic injection of the living patient, we have confirmed the pelvic channels (Fig 5). We believe that such venous extension is the mechanism of production of vertebral osteomyelitis occurring in patients with urinary or pelvic infection. That some of these undergo operation and, shortly thereafter, acquire a spine lesion does not negate the infection theory, but it has sometimes caused the surgical trauma to appear of primary importance. Deming and Zaff[10] were early supporters of this theory in their very thorough study. They believe, as do more and more urologists recently, that all prostatic beds are infected postoperatively, even in patients not considered infected before operation.

CLINICAL EXAMINATION

The clinical and roentgen diagnoses of these vertebral lesions have proved to be very difficult, since tuberculous, typhoid, Brucella and the common pyogenic infections closely mimic one another[9,15,17,25,33] and even appear much like malignant lesions. Surgical treatment, drugs and concomitant disease have added to the confusion.

Pain, the chief complaint, has sometimes been generalized through the back and into the abdomen at early stages but soon it localizes to the vertebral level involved. It has been, characteristically, a pain that is not acute or severe enough in the beginning to necessitate bed confinement nor to arouse alarm in the physician. Reference to the original statistics will show delay

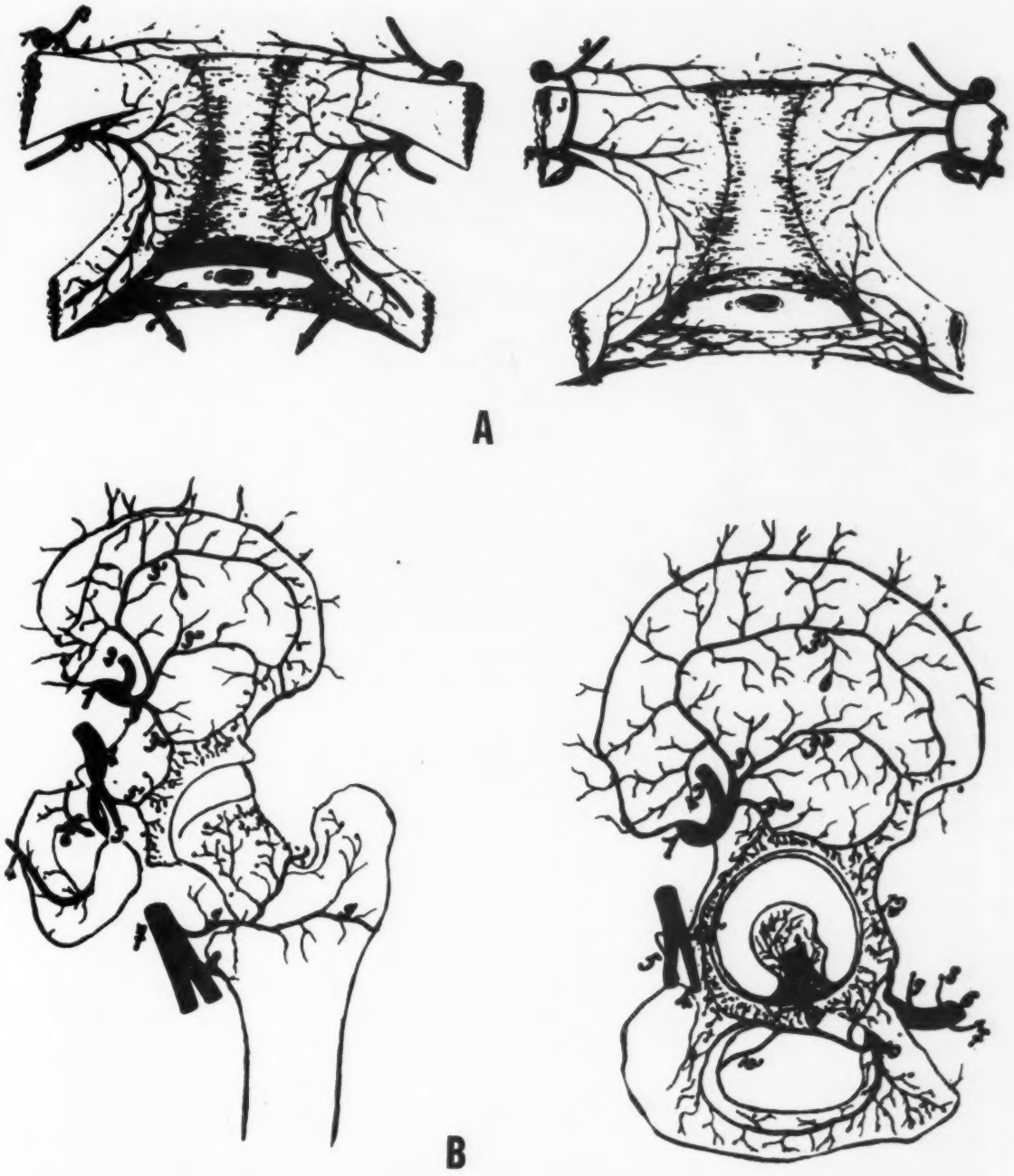


Fig. 4. (*A*) (*B*) From Ribet. Anterior and posterior aspects of the pubes and ischia and posterior and lateral aspects of the hip and pelvis, showing vascular connections in soft tissue and bone.

periods (from onset of pain to first roentgen examination) of three weeks to three years, usually one to two months. "Neurosis" was the first diagnosis in several cases. When the vertebral crush deformity occurred, the patients went to bed in severe pain. This was relieved by hyperextension in several cases. (Often, at this advanced stage, the first roentgenograms have been made.) The onset of pain has occurred from four days to several years following operation or infection, but commonly within several weeks.

Abdominal distention, rarely recorded,

Fig. 5. Transpubic injection of contrast medium in one of our living patients. From the pubis, there are ipsilateral and crossed channels to the obturator, iliac and sacral veins. Urinary tract infection may be supposed to extend by these routes.

has probably existed in many severely affected patients.

Temperature maxima were from 100.6 to 106° F.

Clinical cure, as in the cases of osteitis pubis, has taken place far ahead of healing by roentgen signs. The most rapid was somewhat over ten weeks; the most delayed about one year. The duration statistics surely depend on quality of medical care and patient cooperation, as well as on virulence of organism.

ROENTGEN EXAMINATION

In all types of osteomyelitis of the vertebrae, the location of lesions in order of frequency has been: lumbar, dorsal, cervical. In the 15 cases collected here the sites were: lumbar 6, dorsal 6 and cervical 3.

According to many authors,[9,15,17,25,33] the roentgen appearances are indistinguishable from the lesions accompanying typhoid, paratyphoid and melitensis infection. Early changes are narrowing of the apparent disc space and lytic disease of the adjoining cortices of the bodies. One or more segments may be involved. As the erosive process extends deeper into the bodies, crushing occurs, and usually the disc space progresses toward obliteration (Fig. 6, 7, 8).

At this point, the first roentgen examination may be made (Fig. 6, *A* and *B;* 7, *A* and *B;* 8, *A* and *B*), presenting more than the usual problem of differentiation from malignancy. Cancer in the vertebra usually preserves the disc space, but this can be an unreliable criterion. The cancerous body may well crush around the disc and obliterate the space. The time element is important and may not be accurately known.

The differential diagnosis from tuberculosis also may be difficult, since the loss of disc is common to each, although pyogenic disease attacks the disc earlier and more vigorously.[9] A very important differential characteristic is the degree of regeneration of bone.[7,9]

In pyogenic disease, new bone formation

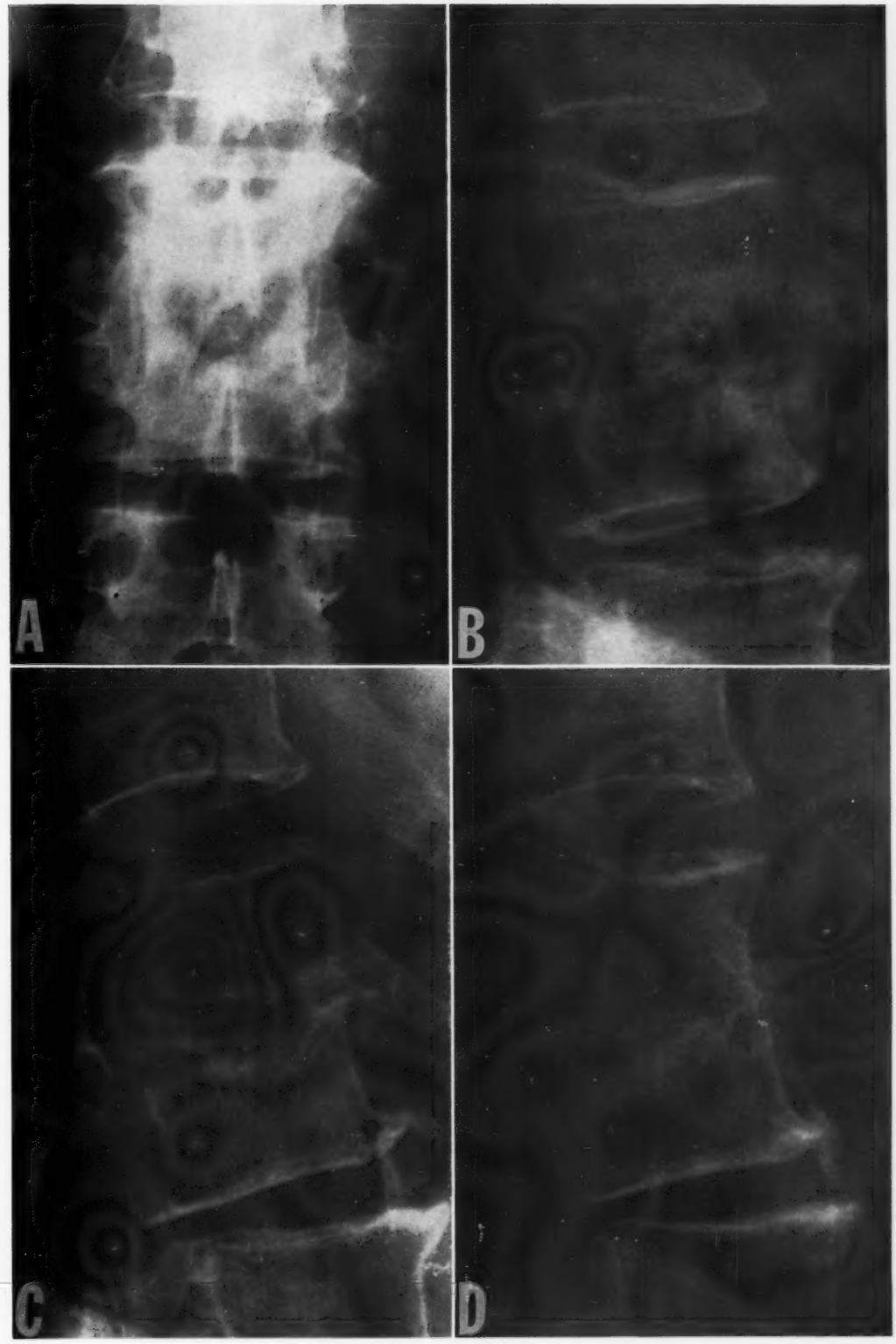


FIG. 6. Case 1. (*A*) (*B*) First roentgen examination, seven weeks after onset of back pain and eleven weeks after a second prostatectomy for prolonged cystitis. Marked destruction at the disc and adjoining cortices. (*C*) Roentgen evidence of healing by proliferation, 6½ months after onset of pain. Clinically well for 3½ months. (*D*) Eighteen months after onset of pain. Healing by fusion and obliteration of disc. Clinically well fifteen months.

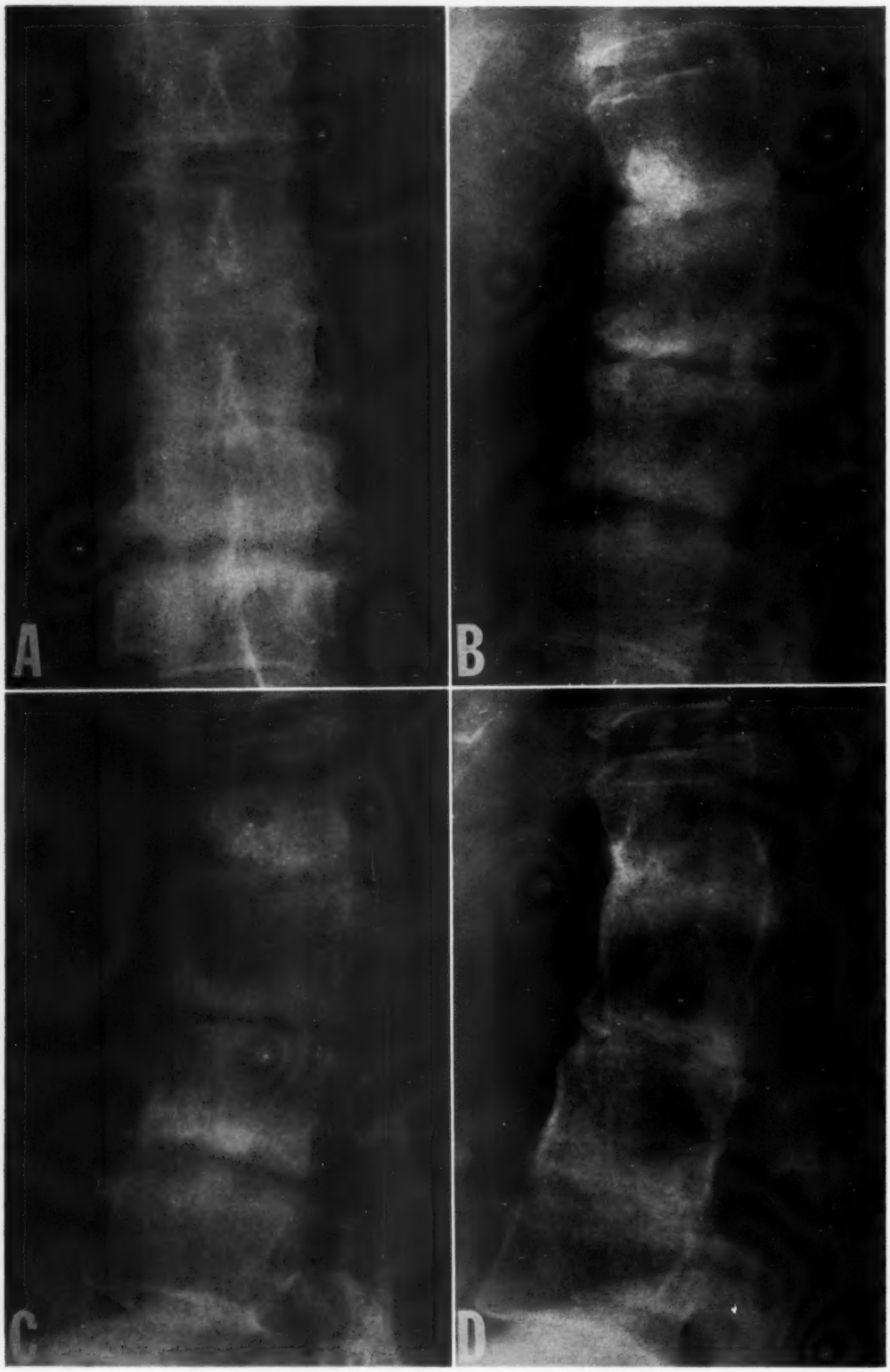


FIG. 7. Case 11. (*A*) (*B*) First roentgen examination, 9½ months after onset of back pain and ten months after hysterectomy and abdominoperineal resection for cancer of the rectum. Lytic and proliferative changes with loss of disc spaces and beginning fusion. Clinically well. (*C*) Two weeks later than (*A*) and (*B*). (*D*) Twenty-eight and a half months after onset of pain. Firm healing by fusion. Clinically well.

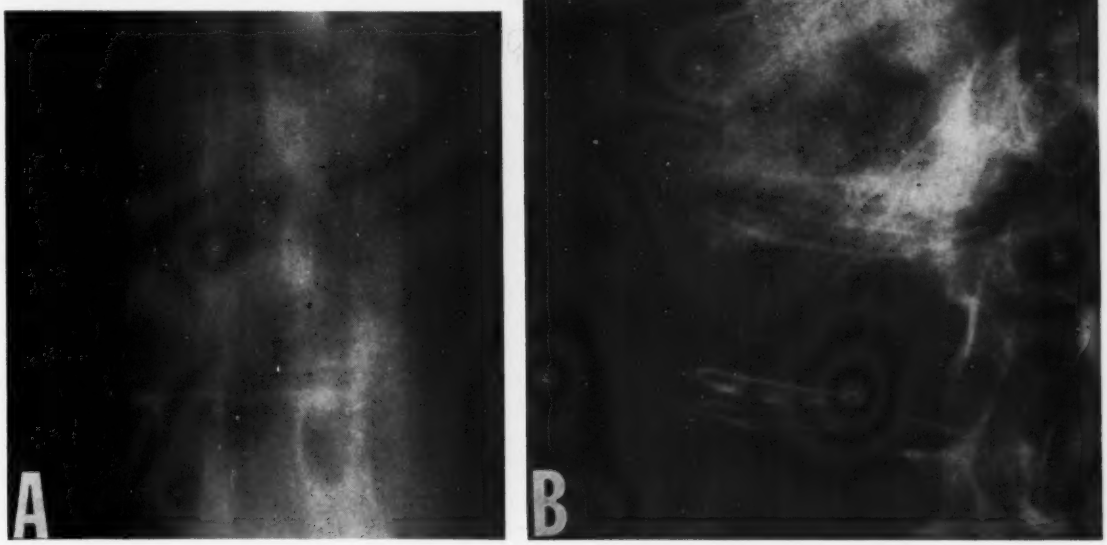


Fig. 8. Case III. (*A*) First roentgen examination (laminagram) of D7 and D8 2⅔ months after onset of back pain and 3¼ months after sigmoid polypectomy. Lytic and proliferative lesion with disc space obliterating. Severe back pain. (*B*) Lateral aspect, showing marked wedging and soft tissue mass.

is common in the healing stages. Our cases reveal this well (Fig. 6*D* and 7*D*). Tuberculous infection, without pyogenic contamination, shows less and later bone production. Guri,[17] after careful comparison of proved cases, stated that there are no reliably characteristic roentgen signs.

However, vertebral fusion, or ankylosis, is a characteristic final roentgen sign. This is a clean, solid, often homogeneous end result, the amount of wedging deformity varying widely (Fig. 6*D* and 7*D*). The disc spaces may be traceable. Fusion occurred in 6 cases of the collected group, was not of record in 7 and did not transpire in 2 fatal cases.

Healing of the lesion by roentgen criteria is poorly documented, because follow-up studies have been irregular or lacking. Of the 7 cases providing such records, healing was seen at from eight months to less than two and one-half years.[10,18,19,29]

LABORATORY EXAMINATION

The informative procedures have been blood leukocyte count, urinalysis and cultures of the urine, blood and bone lesion. Blood leukocytes have ranged from 10,000 to 43,000. Culture of the urine in 9 cases showed Staphylococcus and Pseudomonas in 3, Proteus in 2 cases and the colon bacillus in 1 case. When the blood was cultured, it revealed the same organism as in the urine, in most instances. In 2 cases, the urine organism was cultured from the vertebral lesion.[18,22]

REPORT OF CASES

Case 1. Referred by Dr. Francis G. Harrison. A white male, aged sixty-one, with a benign prostatic hypertrophy, had a suprapubic prostatectomy 11½ months before and a transurethral resection one month before the onset of back pain. At both operations, the anesthesia was by spinal pontocaine and procaine and was

considered satisfactory. Infected urine had persisted for a year, but was cleared at the second operation. Seventeen days before onset of back pain, he noted bloody urine and difficulty initiating the stream and had fever to 102.4° F. Sulfonamide and antibiotics cleared this. Blood cultures were negative one month and ten days before onset of pain.

This long period of urinary tract infection culminated on May 19, 1952, in a gradual onset of pain at the sacral level. Soon it became intermittent, "electric like," radiating through both hips into the thighs, accompanied by severe loss of lower limb motor power. The limb pain occurred about five times a day for thirty minutes each and numbness intervened. The pain at the sacral level was worse and continuous. At the first roentgen examination, July 10, 1952 (7 weeks after onset), the man was confined to bed with severe pain. Flexion and rotation of the trunk could be done only in slight degree and the lower limbs were cool and hypersensitive to pin prick. Temperature was 98.4 to 99° F., leukocyte count 6,100 to 10,800, with 74 to 78 per cent neutrophils. Sedimentation rate was increased and alkaline phosphatase was normal.

The first roentgen examination on July 10, 1952, revealed a nearly obliterated 2nd lumbar disc space, an irregular lysis of the adjoining bodies and an early crushing deformity (Fig. 6, *A* and *B*). We thought this lesion was a malignancy, perhaps metastasis from the urinary tract or a rare primary chondrosarcoma. We pressed a diagnosis of malignant tumor in this man, because of his long illness of several recurrences. Carcinoma of the kidney or of the prostate (with a rare lytic extension) seemed necessary of exclusion, even though all tissues up to that time had been benign. A biopsy with roentgenoscopic guidance was done at our suggestion. The tissue from the disc space showed only "reactive proliferation of bone," and yet we were not convinced.

The patient was put in strict hyperextention in bed, given penicillin and streptomycin and roentgen therapy. He improved immediately; in six days he had lost most of his night pain and in two weeks all of his pain. In one month (3 months after onset) he was out of bed walking and has been well since. The first roentgen evidence of healing was seen at $6\frac{1}{2}$ months after onset of pain (Fig. 6*C*) and firm healing with fusion at eighteen months (Fig. 6*D*). The lag of roentgen healing after clinical cure is typical.

Comment. The rapid relief probably was due chiefly to hyperextension, although both drugs and irradiation were being used simultaneously. The roentgen dosage was 2,800 r in four weeks, much more than suitable had we made a correct diagnosis. For tunately, the patient has shown no harmful result. This same error has often been made in osteitis pubis and is one reason for reporting these cases.

This man had a history negative for typhoid, undulant fever, tularemia, mumps and erysipelas. Febrile agglutinations and blood and spinal serologic tests were negative in 1953, after his recovery.

Case II. Referred by Drs. Donald Riegel and John C. Howell. A white female, aged fifty-five, had a panhysterectomy and an abdominoperineal resection of the rectum and sigmoid on July 25, 1951, for carcinoma of the rectum. Anesthesia was by pentothal, syncurine and cyclopropane and was considered satisfactory. The operation was very difficult, 2,500 cc. of blood was used and the patient was in shock postoperatively. By the ninth day, she was "doing well." On the twelfth day, there was bladder incontinence, the perineal wound was in good condition, the temperature was 101.4° F. and *backache began*. In two days the temperature was 103° F., bladder retention occurred and 600 cc. of cloudy urine was removed. This carried 15 to 20 white blood cells, and 5 to 10 red blood cells per high power field. No urine or blood culture was done. Unless a preoperative brawny, stasis dermatosis of the leg could be so considered, the cystitis was the only known cause for fever. By the twenty-third postoperative day, the temperature was nearly normal, the patient was comfortable, and therefore was discharged.

Preoperative medication was penicillin, sulfasuxidine and dihydrostreptomycin. Postoperatively, she had penicillin, dihydrostreptomycin, permanganate irrigation of the wound and bladder and, later, penicillin and Gantrisin.

At home, the patient suffered increasingly from lumbar pain and was confined to bed with it for eight months (September, 1951, to May,

1952). No special treatment was used. She felt at times as if her lower limbs were paralyzed.

In May, 1952, ten months after operation and onset of pain, the first roentgen examination showed partial obliteration of the 1st, 2nd and 3rd lumbar disc spaces and a combined lytic and condensing disease of the bodies near the disc spaces (Fig. 7, *A* and *B*). One body was wedged. We considered this lesion chronic infection. There were other bone densities of the pelvis and femora that caused us to lean somewhat in favor of metastases from the sigmoid cancer. (It is alarming to realize the inconsistency in roentgen diagnosis that we showed in Cases I and II within a period of 6 weeks.) Metastases were not confirmed and our examination 2⅓ years after onset of pain revealed firm fusion (Fig. 7*D*). The patient has been well since ten months after operation.

Comment. Contrasted with Case I, this woman had an untreated spinal lesion, with a clinical illness of ten months, rather than three months. Such comparison is unscientific, but should be made in each of these uncommon cases.

The patient's history was negative for mumps, erysipelas, typhoid, undulant fever, tuberculosis or lues. Febrile agglutinations and blood serologic tests were negative two years after operation (not performed earlier).

Case III. Referred by Dr. O. K. Reed. A white male, aged sixty-five, had a sigmoid polypectomy (by laparotomy) on April 1, 1954, at another hospital. The lesion was an adenoma with atypism and 1 cm. in diameter. Three days later, there occurred a segmental atelectasis, and temperature readings postoperatively were 98°, 100°, 98°, 102°, 101° and 100° F. On the fourth postoperative day, blood count showed 21,700 white blood cells with 90 per cent neutrophils. He was discharged well on the twelfth day.

The onset of pain occurred twenty days after operation. It was always in the mid-dorsal midline and remained constant and increasingly severe until our first roentgen examination on July 8 (Fig. 8, *A* and *B*). The patient was ambulant, but unable to stand erect or rest comfortably in bed. The history was negative for any type of recent infection of the urinary system, as well as for mumps, erysipelas, typhoid, undulant fever or tuberculosis. Gonorrhea had occurred in 1918, but no symptoms were known after five weeks. Hospital study in July revealed no source of malignant disease, but did suggest cholecystitis. Temperature was normal, white blood cells 10,600, with 72 per cent neutrophils; urine 10 to 15 white blood cells per high power field, and urine culture showed *Pseudomonas aeruginosa* (*B. pyocyaneus*). Blood culture was negative, serum acid phosphatase normal, and blood serology and febrile agglutinations were not examined.

The first roentgen examination showed a lytic disease of the seventh and eighth dorsal vertebral bodies and advanced obscuration of the disc space, with wedging (Fig. 8, *A* and *B*). A soft tissue mass surrounded the vertebrae. This was interpreted as pyogenic osteomyelitis following sigmoid operation. The causative organism is unknown, but, when Pseudomonas is in the urine or blood, as here, experience indicates it as the probable cause. In the absence of any other infection source, Salmonella or colon organisms (from the bowel) would be probable agents.

The patient did not receive drug or postural therapy and was sent home. Very shortly, he returned to his office work; and, when seen three months later (as this report was submitted), he had lost most of his pain. The roentgen examination revealed no certain change.

TREATMENT

There is no immediately successful or decisive therapy. Organisms of the urinary and intestinal tracts have proved very resistant when residing in bone, more so than in the original organs. Antibiotics and sulfonamides have been applied prophylactically and therapeutically without much benefit. However, the newer agents must be tried and no doubt will be used freely. Culture of urine, blood and any other related medium should be done in all cases. If an organism can be isolated, sensitivity tests with drugs may be valuable and should be performed.

Application of such drugs by transosseous vertebral routes may be more effec-

tive, although we have not yet used the method.

Bed rest in hyperextension posture, assiduously applied for several weeks, has been the most valuable measure for relief of pain, fever and crushing of the vertebrae.

For purulent lesions, surgical drainage has been life saving and must always be considered.

SUMMARY

1. Osteomyelitis has arisen rarely from urinary tract infection, which was coupled with operation upon the urinary system. Two such lesions have followed operations on the rectosigmoid. This bone infection has been demonstrated in the pubes and ischia (osteitis pubis). Recent instances of a similar pathogenesis but in the hips and vertebrae have passed through our hands.

2. This report concerns chiefly the third site (the vertebrae) in the triad. There is discussed the relationship of this to the other members and the avoidance of new diagnoses and nomenclature.

3. This osteomyelitis affects chiefly the middle aged male shortly after prostatectomy. Pain in the spine starts insidiously, is usually disregarded or misdiagnosed, but eventually incapacitates.

4. The roentgen diagnosis is difficult because of the rarity of the lesion and the absence of reliable characteristics. Disc destruction is the most valuable early roentgen sign. Bone production and ankylosis are common in late stages.

5. Culture of urine, blood or infected tissue is indicated as the best method of diagnosis and an occasional aid in choosing drugs for treatment.

6. The most useful therapy is bed rest in hyperextension. Antibiotics of the future should be tried.

7. The obscure infections causing the pubic-hip-vertebral disease may be expected to appear in other parts.

Presbyterian Hospital
51 North 39th St.
Philadelphia 4, Pennsylvania

DR. RALPH S. BROMER, Bryn Mawr, Pennsylvania. Dr. Lame is to be congratulated and commended for bringing these cases to our attention. He is one of the authors of papers who sends very early to those who are to discuss his paper, a copy of the text and illustrations, and he is a rare author in that he wrote on the first page of his communication, "Riddles for Discussion." I shall read three of them:

"1. Why are most of the osteolytic lesions of the spine in the lumbar area? All writers agree that the order is lumbar, dorsal, cervical, sacral.

"2. Why is the involvement almost always one to three vertebrae?

"3. Why is the disease uncommon, especially in view of so many grossly infected cases such as the genitourinary, colon and peritonitis patients?"

I am leaving for other discussants most of the replies to these riddles because, frankly, I cannot answer them. However, I can discuss the rarity of the disease. Possibly the disease is considered a rare occurrence because we do not look for it. I believe it can be mistaken for early metastatic carcinoma and I believe there are others than Dr. Lame who have treated these patients for metastatic carcinoma because I am one of them.

Three years ago at the meeting of this Society I discussed Dr. Saenger's paper on spondylitis in children and Dr. Neuhauser and Dr. Sosman took exception to the fact that both Dr. Saenger and I had said it was a rare condition. I believe Dr. Neuhauser is correct in saying that it is not really rare in children, largely because it is so frequently overlooked. Dr. Sosman mentioned an epidemic of several cases of infection of the lumbar vertebrae following lumbar puncture in a nearby hospital transmitted in the sterilizing apparatus which was not functioning properly. Such source of infection is, I believe, of rare occurrence.

We have had 4 cases of osteomyelitis of the spine in the past three years, all involving the lumbar area but in only one could we find a history of previous urinary or pelvic infection. An orthopedic surgeon told me that he had seen only 4 cases of lumbar involvement due to osteomyelitis and all came to him after having had a previous genitourinary infection or operation.

With that evidence we can say that at least it is comparatively rare. In the years when

typhoid fever was prevalent, we saw few cases, as a rule, of typhoid infection of the spine. One percentage of incidence was given as 0.2 to 0.3 per cent of all cases of typhoid. It is interesting to note that the roentgenographic descriptions of the lesions are similar to the cases of Dr. Lame. There is at first thinning of the space between the vertebrae, later destruction of bone in the body with formation of clasplike projections of bone connecting the bodies and finally bony ankylosis.

Dr. Lame has pointed out these cases following genitourinary infection and I hope there will be some comment on the possible pathway.

Dr. Ross Golden, Los Angeles, California. Dr. Lame mentioned the difficulty which we all encounter in differential diagnosis. I have seen in quite a number of cases a beveling of the corners of the vertebral shadow, which I have come to believe is often present in osteomyelitis and is rarely present in tuberculosis. It is usually associated with increased density of the adjacent bone. I have the impression that this beveled appearance was shown in at least two of Dr. Lame's slides. The normal vertebral body has roughly the shape of a spool, and if you can imagine chipping off the flange of the spool at one side or both sides, you get the idea of this appearance. It has been helpful to me.

Another condition which can exactly simulate osteomyelitis of the vertebrae, as far as the roentgen appearance is concerned, is neurotrophic disease of the spine. I have seen this occur with a single level, and also with multiple levels of involvement.

Dr. Lame (closing). I wish to thank those who participated in the discussion. I am glad to know about the beveling sign. I will certainly look for it in the next case.

REFERENCES

1. Alderman, E. J., and Duff, J. Osteomyelitis of cervical vertebras as complication of urinary tract disease. *J.A.M.A.*, 1952, *148*, 283–285.
2. Barrington, F. J. F., and Wright, H. D. Bacteriaemia following operations on urethra. *U. Path. & Bact.*, 1930, *33*, 871–888.
3. Batson, O. V. Personal communication.
4. Batson, O. V. Function of vertebral veins and their role in spread of metastases. *Ann. Surg.*, 1940, *112*, 138–149.
5. Batson, O. V. Role of vertebral veins in metastatic processes. *Ann. Int. Med.*, 1942, *16*, 38–45.
6. Breschet, G. Récherches anatomiques, physiologiques et pathologiques sur le système veineux et voies anatomiques. Paris, 1832.
7. Bromer, R. S. Personal communication.
8. Carson, H. W. Acute osteomyelitis of spine. *Brit. J. Surg.*, 1931, *18*, 400–408.
9. Compere, E. L., and Garrison, M. Correlation of pathologic and roentgenologic findings in tuberculous and pyogenic infections of vertebrae; fate of intervertebral disk. *Ann. Surg.*, 1936, *104*, 1038–1067.
10. Deming, C. L., and Zaff, F. Metastatic vertebral osteomyelitis complicating prostatic surgery. *Tr. Am. A. Genito-Urin. Surgeons* (1942), 1943, *35*, 287–305.
11. Ducuing, J., Guilhem, P., Enjàlbert, A., Baux, R., and Paillé, J. Les différentes voies d'exploration pelvienne par la phlébographie. *J. de radiol. et d'électrol.*, 1951, *32*, 713–719.
12. Feldman, W. H., and Olson, C., Jr. Spondylitis of swine associated with bacteria of Brucella group. *Arch. Path.*, 1933, *16*, 195–210.
13. Flemming, C. Chronic staphylococcal osteomyelitis of spine. *Proc. Roy. Soc. Med.*, 1935, *28*, 897–902.
14. Friedenberg, Z. B. Osteitis pubis with involvement of hip joint. *J. Bone & Joint Surg.*, 1950, 32A, 924–927.
15. Ghormley, R. K., Bickel, W. H., and Dickson, D. D. Study of acute infectious lesions of intervertebral disks. *South. M. J.*, 1940, *33*, 347–353.
16. Gibney, V. P. The typhoid spine. *Tr. Am. Orthop. Soc.*, 1889, *2*, 19–30.
17. Guri, J. P. Pyogenic osteomyelitis of spine; differential diagnosis through clinical and roentgenographic observations. *J. Bone & Joint Surg.*, 1946, *28*, 29–39.
18. Hurwitz, A., and Albertson, H. A. Cervical osteomyelitis and urinary-tract infection caused by Escherichia coli. *New England J. Med.*, 1950, *243*, 562–563.
19. Kretschmer, H. L., and Ockuly, E. A. Osteomyelitis secondary to infections of genitourinary tract. *J. Urol.*, 1935, *34*, 142–147.
20. Kulowski, J. Pyogenic osteomyelitis of spine. *J. Bone & Joint Surg.*, 1936, *18*, 343–364.
21. Kulowski, J., and Vinke, T. H. Undulant (Malta) fever spondylitis. *J.A.M.A.*, 1932, *99*, 1656–1659.
22. Kusunoki, T. Über einen Fall von Pyocyaneus-Osteomyelitis der Wirbelsäule im Anschluss an Pyelonephritis. *Ztschr. f. Urol.*, 1938, *32*, 699–701.
23. Lame, E. L., and Chang, H. C. Pubic and ischial necrosis following cystostomy and prostatectomy (osteitis pubis). Am. J. Roentgenol.,

Rad. Therapy & Nuclear Med., 1954, *71*, 193–212.

24. Lame, E. L. Arthritis of hip following urinary tract operation. *Radiology*, 1955, *65*, 194–199.
25. Laur, A., and Keller, C. Wirbelosteomyelitis nach Grenzstrangblockade. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1952, *77*, 81–89.
26. Pusitz, M. E., Owen, A. K., Finney, G. A., Lattimore, J. L., and Gerundo, M. Osteomyelitis of spine. *J. Kansas M. Soc.*, 1936, *37*, 265; 313.
27. Ribet, M. Les artères ostéoarticulaires. Alger, 1926, Imprim. moderne. Fig. 19, 20, 26, 27.
28. Saenger, E. L. Spondylarthritis in children. Am. J. Roentgenol. & Rad. Therapy, 1950, *64*, 20–31.
29. Schein, A. J. Bacillus pyocyaneus osteomyelitis of spine; report of case of successful treatment with sulfanilamide. *Arch. Surg.*, 1940, *41*, 740–746.
30. Scott, W. W. Blood stream infections in urology; report of 82 cases. *J. Urol.*, 1929, *21*, 527–566.
31. Silver, C. M. Pelvic bone changes following suprapubic prostatectomy. *Bull. Hosp. Joint Dis.*, 1941, *2*, 10–20.
32. Slutsky, N., and Matlin, P. Pyocyaneus meningitis; review of literature and report of original case. *J.A.M.A.*, 1939, *113*, 1400–1401.
33. Smith, A. DeF. Benign form of osteomyelitis of spine. *J.A.M.A.*, 1933, *101*, 335–337.
34. Sosman, M. C. Personal communication.
35. Ssokoloff, S. Zur Klinik des chirurgischen Paratyphus Erzindjan (Paratyphus N). *Beitr. z. klin. Chir.*, 1925, *133*, 321–353.
36. Sternberg, H. Ueber Röntgenbefunde bei Osteomyelitis der Wirbelsäule und Spondylitis infectiosa. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, *49*, 32–56.
37. Widmann, B. P. Personal communication.
38. Wilensky, A. O. Osteomyelitis of vertebrae. *Ann. Surg.*, 1929, *89*, 561–570; 731–747.
39. Ziegler, G. "Spondylosis chondromalacica" oder blande Osteomyelitis der Wirbelsäule? *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1952, *76*, 85–90.

NEEDLE RENAL BIOPSY UNDER IMAGE AMPLIFIER CONTROL*

By LEE B. LUSTED, M.D., GLENN E. MORTIMORE, M.D.
and JAMES HOPPER, JR., M.D.
SAN FRANCISCO, CALIFORNIA

THE technique and value of renal needle biopsy has been amply discussed.[1,3,4,5,7] Those who have attempted this procedure are aware of the problems involved in introducing the biopsy needle into the kidney. Difficulties may be encountered even though the kidney is normal in size and even though its position has been carefully determined by roentgen positioning with markers. Slight movement of the kidney or inappropriate slanting of the biopsy needle may result in failure to make contact with the kidney or may make the difference between penetration near the hilus, where the vasculature enters the kidney, and penetration in a desirable cortical zone.

To avoid such difficulties, we have made renal biopsies under direct vision, using an amplifying fluoroscope. The apparatus permits fluoroscopy to be done in dim light and does not require the viewer to be dark adapted, so that the needle biopsy procedure can be performed without interruption. In addition, we have found that the use of a contrast medium makes it possible to visualize the renal calyces and to insert the needle between them. We recommend the use of a contrast medium if the patient's renal function is sufficient to promise increased density of the renal structures and if there are no contraindications to its use. The renal shadow is less well seen without a contrasted medium and, of course, the pelvis of the kidney is not distinguishable. In developing our procedure, we attempted to use metal markers positioned by roentgen projection over the lower pole of the kidney as a guide to inserting the needle. This technique led to frequent failures, whereas we have had few failures when a contrast medium was used. We believe the one failure in ten attempts was due to a needle of inadequate length. The patient was very thick.

PROCEDURE

The procedure is as follows:

1. The patient's abdomen is palpated and a mark is placed on the skin of the back in the lumbar region at a point where the lower pole of the kidney is believed to be.

2. Contrast medium (30 cc. of 50 per cent hypaque) is then injected intravenously.

3. The patient is placed in a prone position.

4. A wheal is made with 2 per cent procaine (or another suitable local anesthetic) at the spot previously marked on the patient's back. The small skin needle is left in place at the site of the wheal; the syringe is removed. The needle is then viewed with the fluoroscope. If the needle is properly aligned with the lower pole and cortex of the kidney, a long 20-gauge spinal needle is substituted and deep injection of procaine is made toward the renal capsule. If the skin needle is improperly placed, a new wheal is made, using the first site as a guide to repositioning.

5. The skin is nicked with a scalpel in the middle of the anesthetic wheal to allow easy entry of the biopsy needle. We have employed a long (12½ cm.) Vim-Silverman needle.

6. The needle is introduced, using frequent direct visualization to place the needle point in the desired spot, and inserted until the firm resistance which character-

* From the Departments of Radiology and Medicine, University of California School of Medicine, San Francisco, California.
Aided by a grant from the James K. Moffit Fund, allocated by the Committee on Research of the University of California School of Medicine, San Francisco, California.

izes renal tissue is met. When the needle tip is appropriately placed, the patient is instructed to take a deep breath. This will cause the exposed end of the biopsy needle to swing in an arc in a sagittal plane. After this test of positioning has been made, the patient is instructed to breathe lightly to prevent undue motion of the kidney which might lead to renal trauma.

7. A biopsy specimen is obtained by appropriate manipulation of the needle sleeve over the cutting edge. The needle unit can be removed without the need of direct vision.

8. The patient is kept in bed for the remainder of the day and remains in the hospital for eighteen to twenty-four hours unless there are indications for a longer stay. The blood pressure is taken every half hour for two hours and then at one or two hour intervals for the rest of the day. Samples of all voided urine are saved and examined grossly to detect hematuria which often occurs to a moderate degree.

CONTRAINDICATIONS

There are several contraindications to renal biopsy:

1. Sensitivity to contrast media. This is well known and will not be discussed here.

2. The presence of a bleeding tendency. It is desirable to interrogate the patient concerning bleeding tendencies and to determine the bleeding, clotting, and prothrombin times.

3. Severe renal insufficiency. Patients with severe renal insufficiency have shown a tendency to bleed[8] even though the platelet count and the prothrombin, bleeding, and clotting times were normal. The tendency is usually readily ascertained from the history and physical examination.

4. Presence of kidney infection. Pyonephrosis, abscess, and tuberculosis of the kidney are commonly considered contraindications to renal needle biopsy because a spread of infection may result from the procedure. Non-specific pyelonephritis is not a contraindication.[7] One might question the use of biopsy in the presence of diabetes with pyelonephritis.

5. Unilateral kidney.

DISCUSSION

The described technique for direct vision renal needle biopsy has one main technical limitation. Our amplifying fluoroscope in its present stage of development, while it makes it possible to place the needle point in two dimensions, does not permit perception of depth. As mentioned under *Procedure*, contact with the kidney is recognized only by the feeling of resistance offered by the renal tissue. The technique would be greatly improved if depth perception could be obtained. Although this could be accomplished by rotating the patient, the motion of the patient with the needle in place increases the danger of tearing the kidney. Other alternatives would be to use either two fluoroscopic units mounted at right angles or a single fluoroscopic unit which could be moved in an arc about the point of the needle as it approaches the kidney. The Chamberlain multiplane fluoroscope with image amplifier would be excellent for this purpose. It is our plan to try it.

Renal biopsy by the technique we have described has the advantage of increasing the certainty of obtaining appropriate biopsy material and decreasing the hazard to the patient. We would like to express the opinion, however, that renal needle biopsy should not be done promiscuously, inasmuch as the procedure, even under image amplifier control, entails some risk to the patient. It is of value in cases where appropriate treatment cannot be instituted until a precise diagnosis is made. The importance of accurate diagnosis in renal disorders has been discussed elsewhere.[2] In the rare instance when a diagnosis cannot be made on the basis of history, physical examination and urinalysis, renal needle biopsy is warranted. Its use is not justified, however, in cases where a more precise diagnosis will not aid in treatment and in cases of terminal renal disease in which anatomic diagnosis may be difficult, even at postmortem examination.

We are not willing, as Muehrcke, *et al.*[7] are, to do biopsies on any patient with diffuse renal disease who is able to cooperate and to undergo the procedure.

It is apparent that a difference of opinion does exist—even among members of the same department[5,7]—on the value of renal needle biopsy. Kipnis, *et al.*[5] believe that until further experience is gained and the contributions of the procedure are established its use should be restricted.

The particular value of renal needle biopsy is in exploring the aspects of renal disease and the effects of treatment which have evaded the scrutiny of the pathologist in the past. We have in mind the anatomic changes involved in the nonlethal stages of renal disorders, such as acute and subacute glomerulonephritis, and the host of disorders designated as the chronic nephroses, including Kimmelstiel-Wilson's disease, systemic lupus and amyloidosis.

SUMMARY AND CONCLUSION

1. Needle renal biopsy under direct fluoroscopic vision has been described.

2. Contraindications to renal needle biopsy are briefly discussed.

3. Use of the amplifying fluoroscope improves the technique of renal needle biopsy, both with respect to the safety of the patient and the certainty of obtaining adequate tissue.

4. Renal biopsy provides the means of studying renal disease and of improving our diagnostic acumen. Biopsy should only be done when a diagnosis cannot be made by other means and when a specific diagnosis is needed.

Lee B. Lusted, M.D.
Department of Radiology
University of California
Medical Center
San Francisco 22, California

We wish to express our thanks to Dr. Howard L. Steinbach, who suggested making renal biopsies under direct vision using an amplifying fluoroscope, and to Dr. Earl R. Miller, who designed the apparatus we used. This apparatus consists of a Philips image amplifier with an accompanying mirror system and 16 mm. camera. The apparatus is described in a recent publication.[6] Construction of the equipment was financed in part by grants from the American Cancer Society and from the Research Committee of the University of California School of Medicine.

REFERENCES

1. Burneboe, M., Brun, C., Gormsen, P., Iversen, P., and Raaschou, F. Nephrotic syndrome. I. Histological changes illustrated by means of biopsy of kidney. *Acta med. Scandinav.*, 1952, Suppl. 266, 233–248.
2. Hopper, J., Jr., Bolomey, A., and Wenneslland, R. Chronic renal insufficiency. Part I. Appraisal of patient; Part II. Treatment. *Ann. Int. Med.*, 1954, *41*, 18–35.
3. Iversen, P., and Brun, C. Aspiration of biopsy of kidney. *Am. J. Med.*, 1951, *11*, 324–330.
4. Kark, R. M., and Muehrcke, R. C. Biopsy of kidney in prone position. *Lancet*, 1954, *1*, 1047–1049.
5. Kipnis, G. P., Jackson, G. G., Dallenbach, F. D., and Schoenberger, J. A. Renal biopsy in pyelonephritis. *Arch. Int. Med.*, 1955, *15*, 445.
6. Miller, E. R., Lusted, L. B., and Nickel, E. D. Cineradiography. Institute of Radio Engineers Convention Record. 1955, Part 9, 119–123.
7. Muehrcke, R. C., Kark, R. M., and Pirani, C. L. Biopsy of kidney in diagnosis and management of renal disease. *New England J. Med.*, 1955, *253*, 537–546.
8. Zelman, S. Fatal hemorrhage following needle biopsy in uremia. *J.A.M.A.*, 1954, *154*, 997

A REVIEW OF THE COMPLICATIONS OF TRANS-LUMBAR AORTOGRAPHY

By JOHN G. McAFEE, M.D., *and* JAMES K. V. WILLSON, M.D.
Department of Radiology, The Johns Hopkins Hospital
BALTIMORE, MARYLAND

THOSE familiar with the procedure of aortography consider it to be generally safe without significant morbidity or mortality. Serious and varied complications have occurred from time to time; they have, however, had a tendency to become buried and forgotten in the large volume of literature on aortography. It therefore seems worthwhile to summarize these complications to bring them into clearer focus. This report is based on a reasonably complete review of the English literature, the available foreign literature, and the Johns Hopkins' series of 150 aortographies.

Few fatalities from aortography have been reported. In the pioneer work of dos Santos,[10] 4 postaortographic deaths occurred in the first 500 cases. After this, however, many series, each containing several hundred cases have been done without mortality or serious morbidity. Smith, Rush and Evans[43] have performed over 1,000 aortic punctures without incident. Melick and Vitt[28] in 1948 collected 3,000 cases without a fatality, and no deaths occurred in another review[1] of 3,500 cases. In our series, there has been 1 death and 1 case of renal damage requiring nephrectomy.

The most important complications are renal damage from local reaction to the contrast media, bleeding from the puncture site, intestinal damage from direct injection of the superior mesenteric artery, and anesthetic complications. This group accounts for practically all of the complications in our series and most of the serious ones reported in the literature. Systemic reaction to the contrast medium was important when sodium iodide was used, but this is of minor importance with the organic iodized contrast media. Other complications mentioned in the literature include perforation of a viscus, injection of other branches of the aorta, air embolism, peripheral vasospasm, cerebral complications, spinal cord paralysis, effects on the uterus, and pneumothorax. A summary of our experience is presented in Table 1. The various complications will be considered individually in their possible order of importance.

I. *Renal Complications*

Recently, a number of renal complications have occurred at several institutions, and at the present time, this appears to be the most important hazard. In almost all instances, renal damage is associated with excessive amounts of contrast substance in the kidneys. In the usual examination where this is avoided, there is no renal damage.

A few pathologic studies of the kidneys following the injection of media have been carried out. Baccaglini and Ballarin[3] injected dogs with sodium iodide; multiple hemorrhages occurred in the glomeruli of the kidneys, and also in the liver and spleen. Nelson[32] was unable to detect any

TABLE I

SUMMARY OF COMPLICATIONS IN JOHNS HOPKINS HOSPITAL'S SERIES OF 150 AORTOGRAPHIES

1.	Direct injection of a renal artery—3 cases; permanent renal damage—1 case
2.	Hematoma from bleeding of the aortic puncture site—5 cases, 1 fatality
3.	Direct injection of the superior mesenteric artery—1 case, without effect
4.	Direct injection of other vessels—4 cases of direct injection of a lumbar artery
5.	Extra-aortic extravasation of the medium—11 cases
6.	Complications of general anesthesia—2 cases of laryngospasm

changes in the intima of the renal arteries in kidneys surgically removed immediately after or some days after aortography with sodium iodide. One group of authors[6] considered that direct irritation by the contrast medium could cause a pyelo-ureteritis, but no instance of this has apparently occurred. Miller, Wiley and Hinman,[31] using dogs, forcefully injected a mixture of India ink and diodrast into the renal artery or into the aorta occluded just below the renals. Subcapsular and interstitial extravasation of the mixture occurred; the microscopic study of the kidneys three weeks after injection showed patchy interstitial fibrosis.

Renal function studies done before and after aortography on 38 patients by Larsson and Palmlöv[26] demonstrated that there is no detectable change in the usual aortogram. In a case in which 30 cc. of 70 per cent diodrast was injected directly into the renal artery, however, a temporary diminution in function occurred, as demonstrated by urea clearance tests.

Eight cases are known in which oliguria or anuria has resulted from bilateral renal shut-down. The condition is usually temporary, but 2 of the cases were fatal. Many of these cases had high aortic obstruction causing an excessive proportion of the medium to enter the kidneys. Leriche, Beaconsfield and Boëly[27] encountered one severe reaction with temporary oliguria, urticaria and vomiting. The case of Root[37] had complete embolic obstruction of the lower aorta; three injections of 20 cc. 70 per cent urokon were made through two needles just below the renal arteries, resulting in dense opacification of the kidneys and temporary renal shut-down, necessitating peritoneal lavage and an artificial kidney. One of the 4 early fatalities of dos Santos[10] had amyloidosis of the liver and kidneys and developed anuria twenty-four hours after aortography. In the other fatal case of Fry,[18] 10 cc. and 40 cc. of 70 per cent urokon were injected into the aorta directly between the renal arteries causing intense opacification of the kidneys. An additional two injections of 25 cc. were made at a lower puncture site, and an eight day film showed biliary excretion of the urokon. The patient developed severe oliguria, uremia and died of aspiration pneumonia.

Miller, Wiley and Hinman[31] reported 4 cases of temporary anuria or oliguria lasting for eight to eleven days. In all 4 cases, the medium was 70 per cent diodrast and the amount injected into the aorta was 50 to 70 cc. Three of the 4 cases had partial obstruction of the aorta or iliac branches secondary to arteriosclerosis. The two-needle technique of injection was used in 3 cases, and a pressure apparatus was used in the fourth. Two cases developed severe back pain immediately following injection and 2 developed a sensitivity rash. One of the 2 latter cases also had headache and transient hypertension. Three cases developed nausea and vomiting and 2 cases continuous hiccoughs.

The accidental injection of the contrast medium directly into a renal artery, with intense opacification of the renal structures need not result in renal damage. This has occurred at least a dozen times in the literature without any apparent complications.[5,18,21,26,28,31,37,40] In 2 of these cases, the medium was 80 per cent sodium iodide, the most irritating contrast substance. Hartnett[21] injected 15 cc. of 80 per cent sodium iodide without incident in 1 case, and Melick and Vitt[28] injected an unstated amount, causing only temporary lumbar pain and microscopic hematuria. In the authors' 2 cases, the amount of medium injected directly into the renal arteries was quite small (3 cc. in 1 case, and 15 cc. in two injections in the other). In the case of Hinman[23] and also of Fry,[18] an aberrant renal artery was directly injected, resulting in a partial nephrogram and the medium was retained for as long as twenty-four hours in the latter case.

At least 5 cases of unilateral renal damage have occurred as a result of direct injection into a normal or aberrant renal artery, or into the aorta near the origin

of a renal artery, causing a disproportionate quantity of medium to reach one kidney. In all cases thus far, the right kidney has been involved. Miller, Wiley and Hinman[31] reported 3 such cases; in 2 of these the injection was made by a mechanical pressure apparatus, and in the other, the two-needle technique was used—two injections of 50 cc. 70 per cent urokon in 1 case, 50 cc. of 70 per cent diodrast in the second, and 70 cc. of 70 per cent diodrast in the third case. Two of 3 cases had extravasation of the contrast medium around the renal arteries. A few hours after the injection, 1 of the patients developed severe right flank and costovertebral angle pain and tenderness, nausea and vomiting, fever and gross hematuria. In this case the resultant damage was a peripheral renal infarct which was pathologically proved. In another case, an atrophic poorly functioning kidney resulted; in the third case temporary hypertension and temporary nonfunction of the kidney occurred, reverting to normal in about six weeks.

In the case of Ramey and Polley,[35] with thrombotic obstruction of the lower aorta, a 15 cc. dose of 70 per cent urokon was injected into the aorta right at the origin of the right renal artery with intense opacification of the right kidney. Following the procedure, persistent pain in the right costovertebral angle developed, and intravenous urograms showed no evidence of function in the right kidney. Differential renal function studies with indigo carmine three weeks after the aortogram showed poor function in the right kidney. Films three and a half weeks following aortography showed some evidence of right renal atrophy.

In the 150 aortographies at the Johns Hopkins Hospital, 1 case of unilateral renal damage occurred. It is of some interest, because pathologic studies were obtained; it is therefore reported in detail.

REPORT OF CASE

Renal Damage Secondary to Accidental Direct Injection of 70 Per Cent Urokon into Right Renal Artery in Translumbar Aortography. L.W., JHH no. 658635. This thirty-three year old white female had malignant hypertension of at least two years' duration with severe attacks of bitemporal headache, marked hypertensive retinopathy and mild congestive failure. The average blood pressure was about 210/130; urinalysis revealed one plus albuminuria with occasional red blood cells, white blood cells, and cellular casts. Renal function studies were somewhat below normal. Intravenous urography showed normal renal structures. Translumbar aortography was performed under local anesthesia to rule out the possibility of a renal lesion causing the hypertension. Even after heavy sedation, the patient was extremely apprehensive during the procedure and moved violently during the preliminary injection of 8 cc. of 70 per cent urokon into the aorta. This film showed the medium in the aorta, but in addition there was a small extra-aortic extravasation. The final dose of 25 cc. of 70 per cent urokon was given by manual injection: This film (Fig. 1) showed that the tip of the aortogram needle had extended into the origin of the right renal artery,

FIG. 1. Case L.W. Renal damage due to the direct injection of urokon into the right renal artery. Note the dense right nephrogram and the peculiar curvature of the upper abdominal aorta to the left.

due to the patient's movements after the preliminary film. Furthermore, there was a peculiar curvature of the upper abdominal aorta to the left, and the origin of the right renal artery was farther to the left than usual. There was excellent visualization of the right renal artery and its branches, an abnormally dense right nephrogram, and rather poor filling of the left renal artery and its branches. Five minutes after the injection, generalized urticaria developed and the next day there was bilateral swelling of the submaxillary salivary glands, indicative of an iodine sensitivity reaction. A film taken four hours after aortography showed abnormal retention of the contrast medium in the parenchyma of the right kidney, with no medium in the calyces or renal pelvis. The gallbladder was well visualized, indicating marked excretion of the urokon in the biliary tract. A film twenty-four hours after the procedure showed no medium remaining in the kidneys, but dense visualization of the gallbladder.

For about one week following the procedure, the patient complained of marked pain in the right costovertebral angle with definite tenderness and splinting, made worse with deep breathing. In the nine weeks following aortography, six bilateral ureteral catheterizations were performed at intervals, and all these examinations showed nonfunction of the right kidney with complete failure to excrete either phenolsulfonphthalein or indigo carmine, the function of the left kidney remaining normal. The follow-up pyelogram films showed progressive atrophy of the right kidney, the left kidney remaining normal in size.

Nine weeks after aortography, a right nephrectomy was done at the same time as the second stage of a thoraco-lumbar sympathectomy. At surgery, the right kidney was about half of the normal size, and grayish in appearance. The right adrenal gland was normal; the right renal artery had a normal appearance and was pulsatile. Examination of the gross specimen revealed minimal capsular thickening, and a somewhat granular underlying surface. The generalized renal atrophy involved the renal cortex more than the medulla. Microscopically (Fig. 2), there was marked thickening of the intima of the renal arteries, but no definite thrombus formation. There was diffuse marked atrophy of the convoluted tubules and some interstitial scarring. Many of the glomeruli were hyalinized but others appeared perfectly normal in contrast. Pigment casts were present in some of the tubules, and there were rare foci of polymorphonuclear leukocytes.

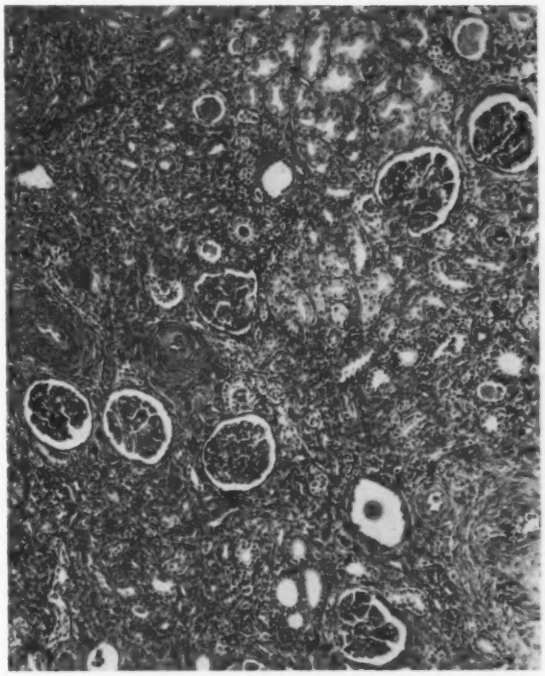


Fig. 2. Case L.W. Photomicrograph of kidney shown in Figure 1 removed nine weeks after aortography. Note the generalized tubular atrophy, glomerular hyalinization and interstitial fibrosis.

Comment. The direct injection of 25 cc. 70 per cent urokon into the right renal artery in this case resulted in immediate and permanent nonfunction of the right kidney, followed by tubular atrophy, glomerular hyalinization, and interstitial fibrosis of the kidney. It is possible that sensitivity to the iodine-containing medium played an important role in the renal damage, as evidenced by the urticaria and salivary gland swelling.

Discussion. The incidence and degree of renal damage appears to be directly related to the concentration and quantity of the contrast medium in the kidneys and it is possibly largely due to direct irritation of the medium on the renal structures. Idiosyncrasy to the medium has apparently played a role in 3 of the cases. The damage has occurred from both 70 per cent urokon

and 70 per cent diodrast. The warning sign roentgenologically is an abnormally dense nephrogram with the medium retained for an abnormally long period, and sometimes with excretion in the biliary tract. Apparently, subclinical damage may occur with temporary reduction in renal function. Clinically, renal complications should be suspected if the procedure is followed by flank pain arising immediately or a few hours after anuria, or oliguria, persistent vomiting, hiccoughs, and allergic manifestations. Large doses of media (over 20 or 25 cc.) as in Miller, Wiley and Hinman's series appear to increase the incidence of complications. The use of pressure injection devices and the two-needle injection technique increases the concentration of the medium reaching the kidney in a given time, and, therefore, should not be used. A preliminary injection of 5 to 8 cc. medium as used by most operators should always be obtained to ascertain the position of the needle. If the needle tip is in the aorta near the renal arteries, or directly within a renal artery, it should be withdrawn and inserted higher. In cases of high aortic obstruction, a large proportion of the contrast material enters the renal vessels. In these cases, satisfactory studies can be obtained with only 10 or 15 cc., and the chance of renal damage is decreased. Perhaps the intra-aortic injection of 3 to 6 cc. of 1 per cent procaine preliminary to the injection of the medium as recommended by Goodwin and Walter[20] may reduce renal arterial spasm. If the above precautions are followed, the incidence of renal damage can probably be greatly lowered. Thus far, the pathologic effect in the kidneys has been interstitial fibrosis, generalized tubular atrophy, hyalinization of glomeruli, and renal infarction.

II. *Bleeding from the Aortic Puncture Site with Hematoma Formation*

In the early years of aortography, the general acceptance of the method as a relatively benign procedure was delayed as the result of the experiments by Henline and Moore.[22] They performed aortography on 19 dogs, using five different contrast media; 8 of the dogs died, 5 as the result of traumatic hemorrhage, and 3 due to drug toxicity. The work, however, was not considered valid by dos Santos[14] and other authors, because aortic puncture is more dangerous in dogs than in humans due to anatomic differences, and because, on the basis of dosage per kilogram body weight, the quantity of media in the experiments was six times that used in aortography in humans. In the larger series of 1,500 aortograms of dos Santos,[16] there was apparently only 1 case of bleeding. Melick, Boler and Black[29] claimed that there was no significant bleeding from the aortic puncture site in over 4,000 aortographies in the literature. Several other authors[5,25] have examined the aorta at surgery from one hour to several days following aortography, and found no hematomas.

Several postmortem studies of the aorta following aortography have been performed. In dos Santos'[14] series of 300 aortographies, 7 persons died from causes other than aortography, and had postmortem examinations. Death occurred from several hours to twenty days after the procedure; in none of the cases was there a hematoma or thrombus formation, and the site of puncture could not be identified in the opened specimen of the aorta. In 3 of the cases, atheromatous plaques were punctured—1 of these died in twenty-four hours and had a small hemorrhage in the muscularis. In another, the aorta showed a small ecchymosis of the adventitia and muscularis. Larsson and Palmlöv[26] reported 4 persons who died eighteen hours to four months after aortography—2 had hematomas. One of these died eighteen hours after aortography and showed a 4 by 5 cm. hematoma. In all cases, the site of the puncture was not visible.

Smith, Rush and Evans[43] performed the procedure in 70 moribund patients and 36 of these, dying from six hours to twenty-four days after the procedure, were followed by autopsy. In the majority, the

puncture site was not detectable. In 6 cases, peri-aortic hematoma was found (an incidence of about 17 per cent) but in none was the hematoma "larger than a golf ball." Three of the 36 had punctures through an atheromatous plaque.

According to Poutasse, Engle and Root,[34] direct puncture of aneurysmal sacs has been performed without bleeding but should be avoided.

In the Johns Hopkins' series of 150 aortographies, 5 cases of peri-aortic hematoma have occurred. In all cases, a No. 17 needle was used and in 4 of the 5 cases the aorta was punctured more than once. Three cases were done under general anesthesia, and 2 with local procaine anesthesia. Three of these cases were insignificant clinically. In 1, the initial injection (Fig. 3*A*) caused peri-aortic extravasation; the second injection at a higher level (Fig. 3*B*) showed definite narrowing of the aorta and origin of both renal arteries from hematoma. In 2 other cases, the aorta was punctured two and three times respectively; films (Fig. 4) revealed a large

Fig. 4. Large left retroperitoneal hematoma obliterating the psoas line and displacing the left kidney laterally. The aorta was punctured three times. Continuous left flank pain for three days resulted.

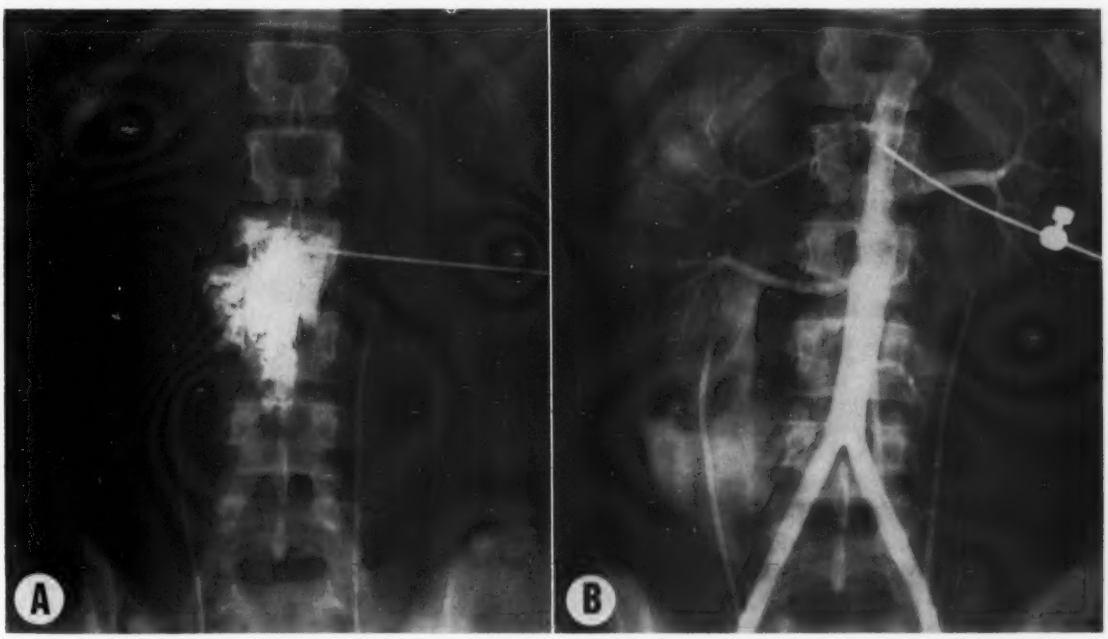


Fig. 3. (*A*) Large extra-aortic extravasation of 75 per cent neo-iopax. (*B*) Needle re-inserted at a higher level than in (*A*); there is narrowing of the lumen of the upper aorta and origin of both renal arteries due to hematoma. No significant symptoms occurred. Note the two right renal arteries, and the perirenal distribution of the extravasated medium.

left retroperitoneal mass displacing the left kidney laterally and obliterating the left psoas line. One of these patients had no symptoms, and the other had only continuous left flank pain for three days.

In another case, an enormous luetic aneurysm of the lower dorsal and upper lumbar aorta was directly punctured four times, in an effort to show the complete outline of the aneurysm. The examination was performed as a "desperate" measure in a poor-risk patient; the examination could be done only in an oblique position. The night following the procedure, the patient complained of more severe abdominal pain than usual and the next morning went into shock. At surgery, about twenty-four hours after aortography, a large peri-aneurysmal hematoma was encountered. The aneurysm was excised, but the patient died from bleeding from several points.

In the fifth case, the hematoma resulted in death; because it is the only fatality as a result of bleeding from the puncture site known to the authors, it is now reported in detail.

REPORT OF CASE

Death from Renal Failure Secondary to Retroperitoneal Hematoma Following Translumbar Aortography. A.H., JHH no. 632624. This thirty-one year old colored housewife had malignant hypertension of at least one year's duration with frequent attacks of headaches, fainting spells, dizziness, palpatations, anorexia, polydipsia, and polyuria. The blood pressure was 280/170. Physical examination revealed Grade III hypertensive retinopathy and some cardiac enlargement. Laboratory studies revealed a four plus albuminuria and a positive serologic test for syphilis. Renal function studies showed bilateral impairment of urine excretion and flow. Intravenous and retrograde pyelograms were essentially negative. Extensive investigations failed to reveal any cause for the hypertension. While in the hospital she developed right lower quadrant pain which was relieved by elevating the foot of her bed. The problem appeared to be a hopeless one unless unilateral renal disease could be found; consequently, translumbar aortography was performed under local anesthesia supplemented by sedation with intravenous demerol. The needle was inserted easily. The aorta was punctured only once. Following a 5 cc. test dose of 70 per cent urokon and a scout film which showed the needle to be in the aorta just above the renal arteries, a dose of 25 cc. 70 per cent urokon was injected. The patient experienced no reaction and the film showed good visualization of normal renal arteries and aorta (Fig. 5*A*). It was felt advisable to rule out the possibility of a mobile kidney causing torsion and ischemia; so the injection was repeated with the patient in a semi-erect position. Again she tolerated the procedure without incident and the film was normal. Twenty minutes later, a film of the kidneys was taken and the patient was again elevated for a film in the semi-erect position. She immediately became unconscious, pulseless and the blood pressure was not obtainable. The film of the abdomen (Fig. 5*B*) showed evidence of a large hematoma displacing the left kidney laterally. She was placed in Trendelenburg position and the pulse and blood pressure gradually returned. The hematocrit, which had been 40, fell to 23. During the next forty-eight hours she was given a total of 4,500 cc. of whole blood. The evening following aortography, after the first transfusion, she developed urticarial lesions which disappeared without therapy. The urine output the first day after the aortography was 3,400 cc. The second day it was 400 cc. and thereafter the urine output never exceeded 150 cc. per day. The nonprotein nitrogen rose steadily and the patient died fifteen days after aortography in acute renal failure.

Postmortem examination revealed a large hematoma surrounding the left kidney (Fig. 6, *A* and *B*). The site of the puncture of the aorta was not identified. There was no evidence of puncture of the left renal artery or vein. Histopathologically, the kidneys showed arteriosclerosis and arteriolosclerosis. Also there was evidence of lower nephron nephrosis manifested by hemoglobin casts in the collecting tubules and widespread focal areas in the cortex in which the convoluted tubules were greatly dilated. Other areas showed necrosis of the tubular epithelium. The changes were equal in the two kidneys.

Comment. This patient went into shock from blood loss following abdominal aortography which included an injection in the

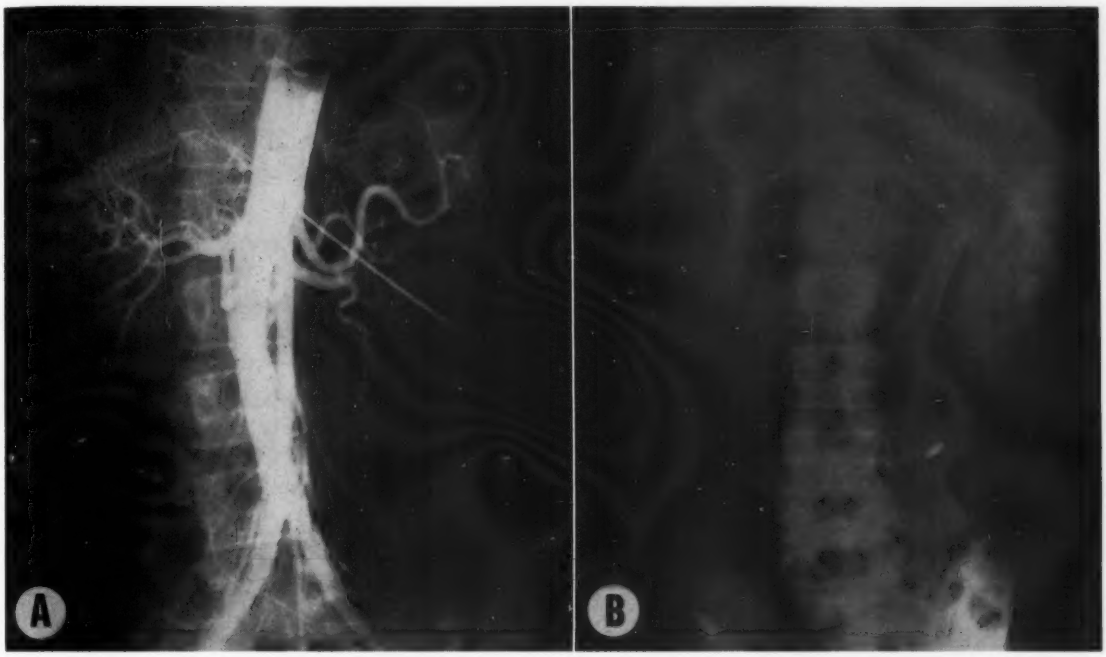


Fig. 5. Case A.H. Death from retroperitoneal hematoma formation resulting in renal failure. (*A*) Normal aortogram. (*B*) Film twenty minutes after aortography showing left kidney displaced laterally by a large hematoma.

semi-erect position. The urticaria several hours after the study indicated a hypersensitivity reaction. This was followed by renal shutdown and death. The histopathologic picture of bilateral lower nephron nephrosis indicated a toxic effect on the kidneys of a systemic nature. It appears that the noxious agent was either urokon or the blood transfusion given shortly before the reaction began.

Discussion. Small peri-aortic hematomas at the site of puncture are not uncommon and larger hematomas are apparently rare. Even in cases where an obvious hematoma

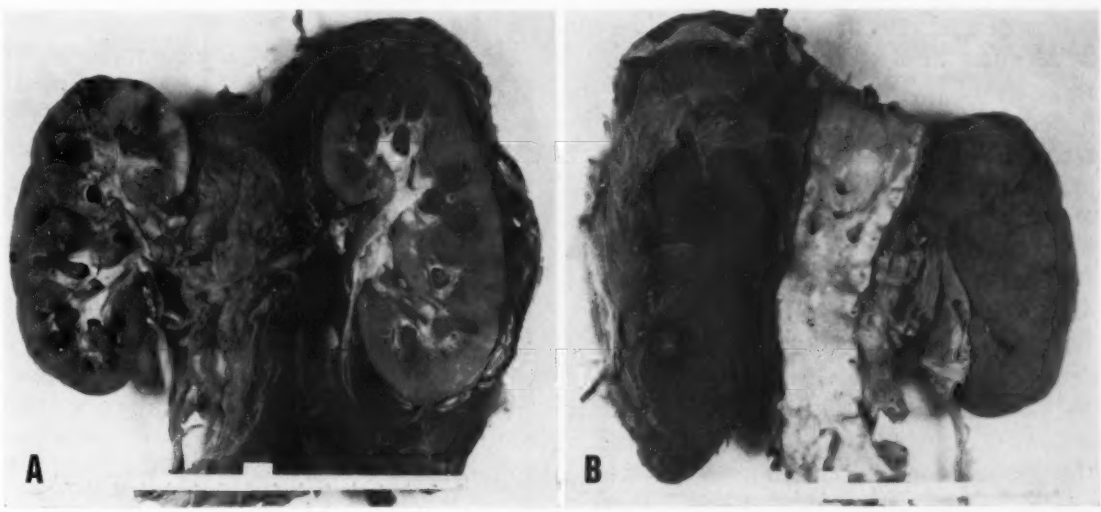


Fig 6. Case A.H. Postmortem specimen of kidneys, (*A*) anterior and (*B*) posterior views showing a large hematoma surrounding the left kidney.

has formed, the aortic puncture site is difficult or impossible to see in the opened aortic wall at postmortem. Judging by our cases, the hematomas tend to form quickly and often appear obvious roentgenographically on the ten minute pyelogram film. Marked flank or lumbar pain, or shock following aortography should arouse the suspicion of hematoma formation. The use of multiple punctures, as used by several authors routinely, is bound to increase the incidence of hematoma formation. Once the needle is in place within the aorta, the patient's position should never be changed, as occurred in our fatal case. A needle bore larger than No. 17 should not be used. Direct puncture of aneurysmal sacs should be avoided.

III. *Direct Injection of the Contrast Medium into the Superior Mesenteric Artery*

In the earlier days of aortography when the medium used was 80 per cent inorganic sodium iodide, the injection of the medium into the superior mesenteric artery was not without danger. Baccaglini and Ballarin[3] demonstrated rather marked inflammatory changes microscopically in the mesenteric vessels following the injection of sodium iodide in dogs. Reagen and Carroll[36] reported a partial injection of 80 per cent sodium iodide into the superior mesenteric artery of a patient without reaction. In the well known fatality of Wagner and Price,[46] 10 cc. of 80 per cent sodium iodide was injected directly into the artery in five seconds causing constant diffuse abdominal pain, shock, and death. No autopsy was obtained on the case. Melick, Byrne and Boler[30] stated that they knew several other fatalities from the injection of sodium iodide into the superior mesenteric artery. In experiments on dogs, these authors demonstrated that direct injection of sodium iodide into the superior mesenteric artery, or into the aorta ligated just below the vessel, caused intestinal necrosis and death. In contrast to this, the direct injection of organic iodine-containing media such as urokon or diodrast did not cause any significant bowel changes.

There are now at least a dozen cases in the literature of direct injection of either 70 per cent urokon or 70 per cent diodrast into the superior mesenteric artery without incident. According to Walter and Goodwin,[47] the injection may cause immediate epigastric pain, nausea and vomiting. In the Johns Hopkins' series, the mouth of the superior mesenteric artery was injected only once with the relatively small dose of 5 cc. of 70 per cent urokon without reaction.

It appears likely that with the use of organic iodine-containing contrast media such as urokon or diodrast, the direct injection of the superior mesenteric artery will give rise to few if any serious complications; it is still advisable, however, to change the position of the needle if entry of the vessel is discovered in the preliminary test injection film.

IV. *Direct Injection of the Medium into Other Vessels*

The direct injection of the medium into vessels other than the renal arteries and superior mesenteric artery has apparently occurred only rarely and has produced few serious complications. Hartnett,[21] Smith, Rush and Evans,[43] and Shapiro[40] each reported instances of direct injection into the celiac axis without incident, Shapiro having 4 such cases. There are at least 5 cases[5,21,37,40] of direct injection into the splenic artery and 3 of these were without effect. In one of Shapiro's[40] 2 cases, the patient developed symptoms "simulating spontaneous splenectomy," but recovered. In the case of Baurys[5] immediate severe pain in the left shoulder resulted, was relieved by morphine, but transiently recurred in the next two or three hours.

Hartnett[21] reported a direct injection into the hepatic artery without incident. Shapiro[40] reported a direct injection into the superior vena cava; the patient stopped breathing for a few minutes, but was revived.

In the Johns Hopkins' series, 4 cases of direct injection into a lumbar artery have occurred (Fig. 7). All cases had dilated

lumbar arteries secondary to thrombotic occlusion of either the iliac vessels or lower aorta. A satisfactory study was obtained by the lumbar artery injection in all cases, and no untoward effects were noted.

V. *Extra-aortic Extravasation of the Medium*

In Nelson's series,[32] 2 early cases of extra-aortic extravasation occurred with 80 per cent sodium iodide; 1 of these had no increase in back pain; the other died a few days after another operative procedure, and at postmortem the tissues at the site of aortic injection were reddened. Reagen and Carroll[36] reported 2 cases of extravasation without noticeable effect, using 80 per cent sodium iodide; in one of these the injection was made completely outside the aorta.

In 4 cases of extravasation of. Melick, Boler and Black,[29] only mild temporary back pain was produced. According to Walter and Goodwin,[47] deep abdominal pain lasting twenty-four hours may occur. Denstad[12] stated that extravasation causes severe pain lasting up to twenty-four hours, but causes no permanent damage. Leriche, Beaconsfield and Boëly[27] have encountered cases where extravasation has been extremely painful, lasting up to twenty-four hours; they recommend injecting 1 or 2 per cent procaine in 100 cc. saline immediately into the area to relieve the pain.

In Hartnett's series[21] of 68 aortographies, extravasation occurred in 13 (an incidence of about 19 per cent). Immediate pain lasting twenty-four hours resulted. In Larsson and Palmlöv's[26] series, extravasation occurred in 7 cases out of 62 aortographies (11 per cent); 6 had only mild symptoms in the back, but one had severe diaphragmatic pain for two or three hours.

Eleven cases of extravasation have occurred in the Johns Hopkins Hospital's series of 150 aortographies, an incidence of 7 per cent. In most cases, transient immediate pain in the back occurred, occasionally with diaphragmatic and left shoulder pain, and occasionally with abdominal pain. The lumbar pain came on

Fig. 7. Uneventful direct injection into the first left lumbar artery. Note the thrombotic block of the left common iliac with dilated lumbar collaterals.

sharply and immediately with the injection, so that extravasation could usually be diagnosed on the basis of the symptoms, even before the films were seen. Residual pain following the injection was insignificant or absent in 8 cases; in 2 cases, moderate pain in the left renal area persisted for one day after aortography. One other case had generalized abdominal pain and nausea on the night after aortography, on recovery from the general anesthetic. In 2 of the cases, the aortogram was technically unsatisfactory because of the extravasation. The medium outside the aorta apparently became dispersed and absorbed quite rapidly, because the ten or fifteen minute pyelogram usually showed the extravasated medium either completely or almost disappeared. In 1 case of gross extravasation, most of the contrast substance was still present on the pyelogram. In this series, fever has not occurred following extravasation. Two of the cases of extravasation also developed a hematoma

as a result of the aortic puncture (Fig. 3, *A* and *B*).

Conclusion. Extra-aortic extravasation of some degree occurs in about 10 per cent of aortographies, and usually produces no effect other than immediate and transient pain in the back, abdomen, left shoulder, or diaphragm. In a few cases, the extravasation has produced severe pain lasting as long as twenty-four to forty-eight hours.

VI. *Complications Secondary to General Anesthesia*

For a number of years, most aortographies were done under general anesthesia, usually intravenous sodium pentothal. After the work of Denstad,[12] Deterling,[13] Weyde,[48] and Melick, Byrne and Boler[30] there has been a definite trend toward the use of local anesthesia with a preoperative sedative. Dos Dantos[14] preferred to use spinal anesthesia; a few authors, objecting to the wave of intense heat which the patient experiences under local,[27,43] still prefer general anesthesia.

Very few complications have been reported as a result of the general anesthetic. Larsson and Palmlöv[26] encountered 1 case of generalized spasm on recovery from the general anesthesia; tourniquets around the lower limbs may have played some role in the production of this spasm. Also, they reported a case of atelectasis of a lung base after general anesthesia.

At this Center, 2 cases of laryngospasm with deep cyanosis have occurred following general anesthesia with sodium pentothal. One of these was only a temporary, mild episode. In the other case, however, severe laryngospasm developed suddenly fifteen minutes after the last injection of the medium, on recovery from the anesthesia on the ward. An emergency tracheotomy and oxygen were necessary to save the patient's life. This patient was comatose for three hours and had a transient left facial paralysis, but subsequently recovered completely.

It is the impression of the anesthesia department of the Johns Hopkins Hospital that the duration and depth of depression after aortography under pentothal are greater than is usually seen in surgical patients receiving a similar amount of pentothal. The reason for this is not known. Possibly it is because a fairly deep anesthesia is required for the brief period of injection when the patient is highly stimulated, but afterwards there is no stimulus to counteract the anesthesia. Another possibility is that the depression of the pentothal is increased synergistically by the contrast medium. The changes in blood pressure, pulse and respirations after the injection tend to be more profound when the contrast medium and sodium pentothal are used together than when either agent is used alone. Transient cyanosis has been commonly observed under general anesthesia. Melick, Byrne and Boler[30] have also encountered cyanosis and increased pulse rate under general anesthesia. The above considerations indicate that local anesthesia is the safer method in cooperative patients.

VII. *Transient Changes in Blood Pressure*

There is some disagreement among various authors as to whether the injection of the contrast medium causes a temporary increase or decrease in blood pressure. Bazy, Rebaul and Racine[6] noted transient hypertension, whereas Leriche, Beaconsfield and Boëly[27] and Larsson and Palmlöv[26] noted temporary hypotension. The latter group noted a fall in blood pressure up to 70 mm. mercury under general anesthesia.

Deterling[13] studied the cardiovascular effect of the injection on 25 dogs and 9 patients. The same pattern of reaction occurred with all contrast media—sodium iodide produced a marked reaction, 75 per cent neo-iopax a moderate reaction and 70 per cent diodrast a minimal reaction. Immediately following the injection, one or two hypertensive beats occurred, followed by a second period of hypotension and bradycardia lasting from a few seconds to over one minute. This was followed by a third period of hypertension and tachy-

cardia lasting from one-half to five minutes.

VIII. *Transient "Normal" Reaction to the Medium*

Under local anesthesia, the "normal" reaction comes on immediately after injection with a wave of heat and generalized flushing, occasionally with nausea and vomiting. Infrequently, discomfort in abdomen or lower chest occurs. Sometimes there is a feeling of fullness in the head,[7] dizziness, and a foreign taste.[39] Rarely a bout of coughing[26] occurs. In a series of sodium iodide aortographies of 12 normal pregnant women reported by Coutts, *et al.*,[11] transient pains in the lower extremities, principally in the feet, were produced. Larsson and Palmlöv[26] reported 3 cases of fever of 38° C. lasting for one day.

The intra-aortic injection of 3 to 6 cc. of 1 per cent procaine immediately before injecting the medium has been recommended by Goodwin and Walter[20] to prevent the crampy pain in the abdomen and extremities which is presumably due to transient arterial spasm. Adrenalin must not be used in the procaine solution. The wave of warmth and the breathlessness as the medium passes through the pulmonary vascular bed are not prevented by this means.

IX. *Acute Iodinism*

Sodium iodide has a much greater tendency to produce this complication than the organic contrast medium. Dos Santos[14] was the first to report serious complications and fatalities from sodium iodide. Nelson[32] reported 4 cases with sodium iodide, but in none were the symptoms alarming. At least 3 other cases[7,47] of acute iodinism are known, but these were not serious. According to Deterling,[13] the tolerance to the intra-aortic injection of sodium iodide is 0.4 gm. per kilogram body weight.

Acute iodinism is characterized by nausea, vomiting, excessive salivation, lacrimation, bronchitis, rash and delayed cerebral depression. A few authors[13,40] use 1,000 cc. isotonic saline intravenously immediately after the procedure to prevent iodinism.

X. *Left Shoulder Pain*

Apparently, left shoulder pain following aortography may occur from several causes. According to Smith, Rush and Evans[43] and also Cooper[9] puncture of the left crus of the diaphragm may cause shoulder pain. Baurys[4] had 1 case of direct splenic artery injection producing marked shoulder pain. Extra-aortic extravasation of the contrast medium with diaphragmatic irritation is another cause. In 1 of our cases, the injection at the mouth of the left inferior phrenic artery resulted in its dense opacification, causing marked transient left shoulder pain.

XI. *Motor and Sensory Paralysis*

In the case report of Antoni and Lindgren[2] a film following the injection of 70 per cent diodrast showed extra-aortic extravasation and filling of only the upper portion of the abdominal aorta and its branches. On recovery from the general anesthesia, there was permanent, complete paralysis and anesthesia from T-12 to L-1 downwards, and urinary incontinence. The patient died three months later. An autopsy showed a normal aorta but marked destruction of the parenchyma of the spinal cord from T-11 downwards. The spinal cord lesion was thought to be the result of ischemia caused by compression of the aorta by a small pillow placed under the abdomen. There is at least one other case of paraplegia following aortography known.[4] In the experiments of Baccaglini and Ballarin[3] some of the dogs developed paraplegia following the injection of uroselectan.

XII. *Effects on the Uterus*

In Hartnett's cases[21] of placental visualization by aortography, transient uterine contractions beginning one to fifteen minutes after injection and lasting five to eight minutes were produced with 15 cc.

of 80 per cent sodium iodide; diodrast had no effect on the uterus.

XIII. *Peripheral Vasospasm due to Irritation from the Medium*

Trifiletti[45] demonstrated that 100 per cent sodium iodide injected intravascularly in dogs caused endarteritis with marked damage to the media and adventitia. Larsson and Palmlöv[26] demonstrated in rabbits that 70 per cent diodrast caused spasm and increased permeability of the vessels.

In the initial studies of dos Santos[14] with 100 per cent sodium iodide, there were cases of impaired circulation with gangrene due to the irritation of the medium. Since the use of organic contrast media began, no actual cases of peripheral vasospasm have been reported, although Leriche, Beaconsfield and Boëly[27] still consider this to be a possible complication.

XIV. *Perforation of Abdominal Viscera by the Needle*

Although a few authors[43] have felt that they have perforated a viscus, without any untoward effects, no cases with definite substantiation are known.

XV. *Pain and Soreness at the Skin Puncture Site*

Although mentioned by a few authors,[43] any significant pain and soreness at the puncture site should be avoided by a properly performed local anesthesia.

XVI. *Air Embolism*

Although it is theoretically possible to introduce air directly into the aorta by the injection,[27] no actual cases are known.

XVII. *Pneumothorax*

Left pneumothorax has been listed[17] as a possible complication of the needle puncture, but no actual cases have been found in the literature.

XVIII. *Cerebral Complications*

Bowman, Forssman and Olsson[8] demonstrated that media of the diodrast type are capable of injuring the cerebral vessels of laboratory animals as manifested by increased vessel permeability, edema, stasis and punctate hermorrhages. Although cerebral complications are an important hazard in aortography of the upper thoracic aorta, they are of no practical importance in abdominal aortography. The only case known is 1 of the 4 early fatalities of dos Santos,[10] a woman with multiple abdominal tumors who died of repeated convulsive episodes twelve hours after aortography.

XIX. *Dangers in Children*

In Campbell's textbook, "Pediatric Urology" it is stated that translumbar aortography in children is dangerous. However, Goodwin, Scardino and Scott[19] performed aortographies in 3 children without difficulty, the youngest eighteen months old. Melick, Boler and Black[29] performed the examination in a five and one half week old infant. These authors claim that aortography should be safer in children than in adults because of the absence of arteriosclerotic changes in the aorta.

SUMMARY

1. Translumbar aortography is a relatively safe procedure with a low incidence of reactions and an even lower incidence of fatalities.

2. Renal damage from local reaction to the contrast medium is the most serious complication. It is probably due to direct irritation of the medium on the renal structures. The incidence and degree of renal damage is directly related to the concentration and quantity of contrast medium entering the renal arteries. A case of renal damage, requiring nephrectomy, secondary to injection of 70 per cent urokon into the right renal artery is reported in detail.

3. Hemorrhage from the puncture site is not uncommon. Usually the hematoma is small and asymptomatic; however, at least 1 fatality from a large hematoma has occurred and this case is reported in detail.

4. Complications may occur from injection of the contrast medium into the su-

perior mesenteric artery and other branches of the aorta, from anesthetic reactions and reactions to the contrast medium. These and several other minor complications are considered individually.

5. The literature on the subject is reviewed and the experience with 150 aortographies at the Johns Hopkins Hospital is presented.

John J. McAfee
Department of Radiology
The Johns Hopkins Hospital
Baltimore 5, Maryland

REFERENCES

1. Abdominal aortography, annotations. *Lancet*, 1952, *2*, 671–672.
2. Antoni, N., and Lindgren, E. Steno's experiment in man as complication in lumbar aortography. *Acta chir. Scandinav.*, 1949, *98*, 230.
3. Baccaglini, G., and Ballarin, G. Aortografia. *Radiol. med.*, 1940, *27*, 1.
4. Baurys, W. Personal communication.
5. Baurys, W. Translumbar aortography. *Pennsylvania M. J.*, 1953, *56*, 451.
6. Bazy, L. Rebaul, H., Racine, M. Précisions sur les solutions de contraste et les facteurs mécaniques utilizés pour l'artériographie. *Presse méd.*, 1935, *43*, 288.
7. Berry, N. E., White, E. P., and Metcalfe, J. O. Abdominal aortography in urology. *Canad. M.A.J.*, 1952, *66*, 215–217.
8. Bowman, T., Forssman, B., and Olsson, O. *Acta radiol.*, 1948, *30*, 326; also, 1949, *31*, 321; also, 1950, *34*, 135.
9. Cooper, J. F. Translumbar aortography. *Bull. New England M. Center*, 1950, *12*, 199.
10. Corachan, M. Arteriografía. *Gazz. Med. Caracas*, 1940, No. 48, 26.
11. Coutts, W. E., Opazo, L., Bianchi, B., and Donoso, S. Abdominal circulation during late pregnancy as shown in aortograms. *Am. J. Obst. & Gynec.*, 1935, *29*, 566.
12. Denstad, T. Abdominal aortography. *Acta radiol.*, 1952, *38*, 187–197.
13. Deterling, R. A., Jr. Direct and retrograde aortography. *Surgery*, 1952, *31*, 88–114.
14. dos Santos, R., Lamas, A., and Caldas, J. P. Arteriographie des membres et de l'aorte abdominale. Masson & Cie, Paris, 1931.
15. Editorial. Aortography. *J. A. M. A.*, 1952, *148*, 652–653.
16. Editorial. Dangers of abdominal aortography. Am. J. Roentgenol. & Rad. Therapy, 1951, *65*, 280–281.
17. Evans, A. T. Translumbar aortography; preliminary report. *Cincinnati M. J.*, 1951, *32*, 47–55.
18. Fry, W. J. To be published.
19. Goodwin, W. E., Scardino, P. L., and Scott, W. W. Translumbar aortic puncture and retrograde catheterization of aorta in aortography and renal arteriography. *Ann. Surg.*, 1950, *132*, 944.
20. Goodwin, W. E., and Walter, R. C. Intra-aortic procaine injections. *Angiology*, 1953, *4*, 410.
21. Hartnett, L. J. Possible significance of arterial visualization in diagnosis of placenta previa. *Am. J. Obst. & Gynec.*, 1948, *55*, 940–952.
22. Henline, R. B., and Moore, S. W. Renal arteriography; preliminary report of experimental study. *Am. J. Surg.*, 1936, *32*, 222–229.
23. Hinman, F. Personal communication.
24. Horton, R. E., and Nanson, E. M. Technique and value of aortography. *Brit. M. J.*, 1953, *2*, 969.
25. Kearns, W. M. Aortography and pneumography in renal diagnosis. *Proc. Inst. Med., Chicago*, 1953, *19*, 235.
26. Larsson, H., and Palmlöv, A. Abdominal aortography with special reference to its complications. *Acta radiol.*, 1952, *38*, 111–124.
27. Leriche, R., Beaconsfield, P., and Boëly, C. Aortography: Its interpretation and value; report of 200 cases. *Surg., Gynec. & Obst.*, 1952, *94*, 83–90.
28. Melick, W. F., and Vitt, A. E. Present status of aortography. *J. Urol.*, 1948, *60*, 321–334.
29. Melick, W. F., Boler, T. D., and Black, H. Translumbar aortography in infants using 70 per cent urokon. *Missouri Med.*, 1953, *50*, 179.
30. Melick, W. F., Byrne, J. E., and Boler, T. D. Experimental and clinical investigations on various media used in translumbar aortography. *J. Urol.*, 1952, *67*, 1019–1027.
31. Miller, G. M., Wylie, E. J., and Hinman, F. Renal complications from aortography. *Surgery* 1954, *35*, 885.
32. Nelson, O. A. Arteriography of abdominal organs by aortic injection. *Surg., Gynec. & Obst.*, 1942, *74*, 655–662.
33. Palmlöv, A. Abdominal aortography, especially with reference to renal diagnosis. *Northern Surgical Association, Official Transactions*, 1947, *23*, 431.
34. Poutasse, E. F., Engel, W. J., and Root, J. C. Translumbar aortography. *Cleveland Clin. Quart.*, 1952, *19*, 105–115.
35. Ramey, W. P., and Polley, V. To be published.
36. Reagen, G. W., and Carroll, G. Arteriography as observed in eighty patients at St. Louis City Hospital. *J. Urol.*, 1951, *66*, 467.
37. Root, J. C. Personal communication.

38. SANTE, L. R. Evaluation of aortography in abdominal diagnosis. *Radiology*, 1951, *56*, 183–192.

39. SCOTT, W. In: Handbook of Radiology, edited by H. R. Morgan, and K. E. Corrigan. Year Book Publishers, Inc., Chicago, 1955.

40. SHAPIRO, D. Abdominal arteriography. *Radiology*, 1953, *60*, 1–17.

41. SHAPIRO, D. Leriche syndrome (thrombotic obliteration of aortic bifurcation). AM. J. ROENTGENOL. & RAD. THERAPY, 1952, *67*, 891–904.

42. SHUMACKER, H. B., JR., and GODLEY, A. F. Arteriography in cases of aneurysm and arteriovenous fistula; with review of literature concerning choice of solution. *Yale J. Biol. & Med.*, 1947, *20*, 273.

43. SMITH, P. G., RUSH, T. W., and EVANS, A. T. Technique of translumbar arteriography. *J.A.M.A.*, 1952, *148*, 255–258.

44. SMITH, P. G., RUSH, T. W., and EVANS, A. T. An evaluation of translumbar arteriography. *J. Urol.*, 1951, *65*, 911–921.

45. TRIFILETTI, I. *Rassegna internazionale di Clinica e Terapia*, 1931, *12*, 531.

46. WAGNER, F. B., JR., and PRICE, A. H. Fatality after abdominal arteriography: Prevention by new modification of technique. *Surgery*, 1950, *27*, 621–626.

47. WALTER, R. C., and GOODWIN, W. D. Aortography and retroperitoneal oxygen in urological diagnosis; comparison of translumbar and percutaneous femoral aortography. *J. Urol.*, 1953, *70*, 526; also, *Transactions of Western Section, Am. Urol. Assn.*, 1952, *19*, 62.

48. WEYDE, R. Abdominal aortography in renal diseases; preliminary report. *Brit. J. Radiol.*, 1952, *25*, 353–359.

49. WEYDE, R. Abdominal aortography in renal tuberculosis. *J. Oslo City Hosp.*, 1951, *1*, 269.

THE ROLE OF IRRADIATION IN THE TREATMENT OF WILMS' TUMOR IN CHILDREN*

By H. DABNEY KERR, M.D., *and* ROBERT E. FLYNN, M.D.

CONTROVERSY still exists regarding the best method of treatment of malignant renal tumors in children. The purpose of this paper is to present the results of treatment of 28 cases seen at the State University of Iowa Hospitals during the period from 1931 to 1951, and to suggest more extensive utilization of preoperative irradiation.

The lesion was first described by Ebenezer Gairdner in the Edinburgh Medical and Surgical Journal of 1828. He referred to it as "fungus haematodes." Marx Wilms published a monograph on the subject in 1899 and since that time his name has been intimately connected with this tumor.

While the true incidence of the disease is not known, it is thought to account for approximately 20 per cent of malignant neoplasms in children and to rank in frequency with ocular neoplasms. The Metropolitan Life Insurance Company[9] recently published data concerning 391 deaths due to cancer in children under the age of four years. Leukemia accounted for 47 per cent, cancer of the kidneys and bladder for 16 per cent and lesions of the central nervous system for 14 per cent. During the same period, cancer of the kidney and bladder for the age group, five to nine years, was six per cent and for the group, ten to fourteen years, only one per cent.

The pathogenesis of these tumors has been discussed in detail by many authors. Birch-Hirschfeld, in 1894, described these childhood tumors as "adenosarcoma" and believed that the wolffian body was the tissue of origin. Wilms thought the origin was the renal blastema or nephrotome. Others, particularly Wu,[11] believed that the origin was embryonic tissue from the true kidney alone, and he accounted for the different elements by metaplasia. Nicholson[10] described an embryonic renal tumor in a fetus. He argued for the developmental origin of the lesion, believing that the tumor represented the malformed organ in which growth continued but differentiation was aborted. Masson[7] described neural crests in the embryonal tumor and concluded that the blastema was, therefore, neurogenic, as well as myogenic, sclerogenic and nephrogenic. Because of the multiplicity of elements present, the term mixed tumor or teratoma has also been used.

Although the tumor is found most frequently in the first four years of life, it has been described in the fetus, the newborn, and in each decade up to and including the ninth. A large, hard mass in the abdomen may be discovered by the parent or the physician during a routine physical examination. Cases have been reported in which rupture of the tumor was the first indication of the disease.

Rare cases of bilateral involvement have been described and one of our cases presented this finding. The lesion has appeared simultaneously in identical twins on opposite sides, in three and possibly four children of one family, in a horseshoe kidney, in the isthmus of a horseshoe kidney and in the remaining kidney of one patient ten years after the removal of the opposite kidney for Wilms' tumor.

The tumor remains confined by the renal capsule until late, and, thus the capsule serves to prevent direct spread to adjacent organs. Microscopic examination shows that these tumors are composed of "isolated tubules of high cylindrical or cuboidal cells with indistinct lumina surrounded by zones of indifferent spindle cells, on which is based the designation adenosarcoma. Either tubules or spindle cells may be in excess, the tumor approaching embryonal adenosarcoma."[2] Scattered groups of embryonic glomeruli, smooth or striated mus-

* From the Department of Radiology, College of Medicine, State University of Iowa, Iowa City, Iowa.

cle and occasionally cartilage, fat and myxomatous tissue may be found in a main mass of "indifferent spindle cells."

There has been considerable opportunity to study the effect of irradiation on these tumors. Following irradiation there is a rapid decrease in the size of the mass due to destruction of radiosensitive elements of the tumor. Histologically, there is necrosis, increase in fibrous stroma, and occasionally large fibroblasts having the appearance of "foreign body-type" giant cells. Perivascular fibrosis is an important feature. Changes in the adjacent kidney consist of degeneration of the tubules, increase in the fibrous stroma and necrosis and hyalinization of the glomeruli.

Some authors believe that calcification in the tumor is a good prognostic sign, whereas hematuria, indicating invasion of the renal pelvis by the tumor, carries with it a grave outlook.

McDonald and Priestley[8] have studied the route of metastasis and have concluded that the tumor cell must enter the circulation at the level of the small renal capillaries, since many times there is no evidence of embolization of the renal vein. Metastasis to the lungs is most common. Twelve of our 28 cases developed pulmonary metastasis and 2 of these 12 had bone involvement. A case is reported in which there was growth of the tumor up the inferior vena cava into the right atrium.[6]

Ferris and Beare[3] report an unusual metastatic lesion occurring in the urinary bladder at the right ureteral orifice six months after the right kidney had been removed for Wilms' tumor. They described the lesion as a 1.5 cm., pedunculated tumor which was resected transurethrally and by microscopic examination was found to be identical with the renal specimen. In all probability, this represented implantation of the tumor in the bladder, since hematuria was the initial complaint.

The course of 20 untreated patients with Wilms' tumor has been recorded by Albarran and Imbert.[1] Fourteen of the patients died within six months and 3 more by the end of the first year. Three were alive after one and one-half years. Only 1 survived three years.

Reports of five-year survial periods have been recorded following treatment by each of the five proposed methods, *viz.*: nephrectomy, preoperative irradiation with nephrectomy, nephrectomy followed by irradiation, nephrectomy preceded and followed by irradiation and by irradiation alone. In Table I are listed the heretofore published cases of five-year survivals by authors according to the method of treatment. To the list of published cases we have added our 5 cases.

A summary of 28 cases treated at the State University of Iowa Hospitals during the twenty-year period, 1931–1951, is presented in Table II. The first 14 cases were previously reported by one of us (H.D.K.[5]) and are included at this time because reference will be made to them. The irradiation dosage is expressed in r air at the portal area.

In general, prior to 1938 treatment was by irradiation alone. In Cases 4 and 14, however, nephrectomy followed the irradiation. Since that time we have advised irradiation followed by nephrectomy if metastases can not be demonstrated.

Case 4 was treated with irradiation followed by nephrectomy and was well for forty-two months before metastasis was detected. Because of this, we are unable to subscribe to the theory that metastasis does not occur after two years. We believe that a two-year period free from recurrence is insufficient to establish a "cure."

Case 5 was treated solely by irradiation and lived for sixty-one months before metastasis was detected. Nephrectomy was advised in this case but the parents would not permit it.

Case 9 demonstrates the palliative effect of radiation therapy. Metastatic lesions were discovered thirty-four months after irradiation of the primary tumor. The metastasis was controlled by subsequent irradiation for twenty-nine months before death finally ensued. It is interesting to

Table I

Author	Five Yr. Survival	Operation	Pre-operative Radiation	Post-operative Radiation	Both	Radiation Alone	Not Stated
1. Abbe	1	1					
2. Barringer	1					1	
3. Beer	1						1
4. Benzing	2			1		1	
5. Charteris	2					2	
6. Childs Hosp. Australia	1		1				
7. Coley	1	1					
8. Daw	2			1	1		
9. Dean	5						
10. Deming	1	1					
11. Dickey and Chandler	4		2	1		1	
12. Everidge	1	1					
13. Gahagan	2			1	1		
14. Goddard	4						4
15. Hazzard	3	3					
16. Higgns and Shively	4	2	1		1		
17. Hyman	1	1					
18. Israel	1	1					
19. Kretschmer	1			1			
20. Ladd and White	8	7	1				
21. Levant	1						
22. Lippert	1	1					
23. Loeb	1			1			
24. Long	1			1			
25. Loughnane	2	2					
26. Mandeville	1		1				
27. McNeil	4		2			2	
28. Nesbit and Adams	6	2	2	1		1	
29. Ocherbold	1			1			
30. Pace	1				1		
31. Priestley and Broders	1					1	
32. Riches, *et al.*	13	6	1	6			
33. Ritter and Scott	1	1					
34. Rowe and Frazer	2			1	1		
35. Rusche	6		2	2	2		
36. Sauer	1					1	
37. Senger, *et al.*	1		1				
38. Silver	6	3		2	1		
39. Stern	2	2					
40. Taylor	1			1			
41. Van Duzen	1			1			
42. Wade	1	1					
43. Weisel, Dockerty, Priestley	5	1		2	2		
44. White	4	2		2			
45. Wilensky	1			1			
46. Wollenstein	2	2					
47. Authors	5		4		1		
	118	41	18	29	11	16	5

TABLE II

SUMMARY OF CASES

Case	Age	Sex	Admitted	Symptoms	Side	Irradiation Primary	Nephrectomy	Metastasis Irradiation	Survival mo.	Comment
1	3½	M	4/ 2/31	15 mo.	Lt.	1,000 r	no	Lt. supra clavicular, 1,000 r	9	Patient too sick to be given adequate irradiation; dilated superficial veins
2	2½	M	10/23/31	1 mo.	Rt.	3 courses 9,000 r	no	Lungs, 3 courses, 9,000 r	28	Primary lesion remained healed; died of metastases
3	6	F	4/ 1/33	6 wk.	Rt.	2 courses 5,200 r	no	Chest 8,000 r Ischium and pubis 3,200 r	26	Two regressions of primary tumor; died of metastases
4	2½	F	7/ 3/33	1 mo.	Lt.	2 courses 4,200 r	10/9/33	Bones—skull, pelvis, Lungs	47	First operative case. Survived 42 months before metastases
5	4	M	7/ 5/33	2 yr.	Rt.	2 courses 5,800 r	no	Rt. flank and pelvis, soft tissue	68	Operation refused. Alive 61 months before metastasis developed.
6	1¾	F	9/ 1/33	2 wk.	Lt.	1,800 r	no	Lungs 4,000 r	5	Regression of primary and lung metastases
7	2	M	11/19/33	5 mo.	Rt.	2 courses 6,400 r	no	no	17	Had fishworm clots and dilated veins
8	3½	M	11/20/33	1 mo.	Both	2 courses rt. 2,200 r lt. 2,200 r lt. 2,400 r	no	no	7	Bilateral. Clinical
9		F	2/ 8/34	1 mo.	Rt.	2 courses 8,200 r	no	Lungs 12/36 lt. chest 12/36 rt. apex 12/37 rt. chest 12/37 lt. hilus 12/38 lt. hilus 9/38 masses	63	Pelvic kidney on left. Lung metastasis cleared twice. Well 6/1/38. Died with pelvic metastases 5/10/39
10	1 10/12	M	3/21/34	1 wk.	Lt.	2,600 r	no	no	3½	Progressively worse during treatment; stopped
11	3	M	8/19/34	2 mo.	Lt.	2,000 r	no	no	6	Not seen after treatment. Well 4 months, then down
12	5	M	2/ 7/35	10 days	Rt.	4,200 r	no	no	8½	Large superficial veins
13	4	F	6/18/35	1 mo.	Rt.	2 courses 5,200 r	no	Lungs 1,200 r	5	Dilatation of superficial veins
14	2½	M	4/20/37	5 mo.	Rt.	3,200 r	8/16/37	no	4	Died following operation. No microscopic evidence of residual tumor
15	3	M	7/11/38	6 mo.	Lt.	4,400 r	no	Lungs 9/17/38 1,600 r	?	Metastases 3 months after diagnosis. Exact date of death unknown
16	3	M	10/14/38	2 mo.	Lt.	4,000 r	12/28/38	8/20/40	26	Patient not seen after 3/19/40. Word that he died 12/15/40. Metastasis to spine
17	6	F	1/ 3/39	6 mo.	Lt.	4,000 r	4/ 6/39	Residual 4,000 r	18	Residual tumor under left side of diaphragm. Contracted polio, 11/6/39 and died 7/9/40 without proved tumor
18	2	M	1/22/40	1 mo.	Lt.	3,400 r	4/ 1/40	Residual 800 r	4	Postoperatively patient died. Could not tolerate radiation.
19	3	F	7/28/42	5 mo.	Rt.	4,000 r	10/19/42	Residual	6	Residual tumor left under liver. Could not tolerate more radiation.
20	2	F	8/27/42	12 mo.	Lt.	3,600 r	11/19/42	10/42 rt. lung 4,000 r 6/43 rt. lung 2,000 r 8/44 rt. lung 2,800 r 4/45 rt. lung 4,400 r	64	Patient died of pneumonia secondary to radiation injury, rt. lung. Autopsy showed no residual or metastatic neoplasm
1	1¾	M	1/27/44	1 mo.	Lt.	4,800 r	5/23/44	no	109	Alive and well
22	4½	F	3/14/44	3 mo.	Lt.	4,800 r	no	Lungs 5/4/44 4,000 r	7	Had lung metastases when returned for nephrectomy. Primary and secondaries regressed with radiation. Died 9/19/44
23	1 7/12	M	2/19/45	½ mo.	Rt.	3,600 r	4/28/45	no	96	Alive and well
24	1 8/12	F	2/19/47	½ mo.	Lt.	3,600 r	5/21/47	no	72	Alive and well
25	1 11/12	F	4/30/47	2 mo.	Lt.	3,600 r	7/11/47	no	70	Alive and well
26	2½	M	12/13/47	1 wk.	Rt.	4,600 r	2/11/48	Lungs April, 48 8,000 r	8	Lung metastases cleared after irradiation, recurred in 3 months. Died 7/7/48
27	4	M	6/19/50	3 wk.	Rt.	3,500 r	9/18/50	Lungs 1/3/51 and 5/17/51 each 2,000 r	13	Extensive lung metastases, recurred after irradiation. Autopsy: fibrosis with several small nodules in lungs
28	1 7/12	F	9/12/50	1 wk.	Lt.	4,800 r	1/15/51	Lt. base Jan., 51 2,400 r Lt. upper April, 51 2,200 r Rt. lung May, 51 2,000 r	11	Lung metastases recurred. Developed pleural effusion. Died 8/2/51

speculate that had a nephrectomy been performed in this case would metastasis have developed?

Case 14 is the only operative death.

Case 20 demonstrates complete disappearance of metastatic lesions following treatment by radiation. The fact that this patient died as a result of infection superimposed on the pulmonary damage produced by the irradiation is disheartening. However, with the present day management of chronically infected lung with antibiotics and thoracic surgery, as well as the possibility of preventing radiation injury with cortisone and dicumeral, a similar unfortunate circumstance might be averted.

Cases 21, 23, 24 and 25 are alive and well, 109, 96, 72, and 70 months respectively following preoperative irradiation and nephrectomy. It is of interest that each of these five year survivals was less than two years old when treated. The observation that those in whom the lesion is discovered before the age of two appear to have a better prognosis is confirmed by our experience.

Of the 28 cases, 11 survived two years and 7 were still alive after 5 years. Two of the 7 (Cases 5 and 9) died of the disease after five years and one (Case 20) died as a result of irradiation of pulmonary metastasis.

It is interesting to compare the length of survival of those treated with radiation alone to those treated with radiation followed by nephrectomy.

Irradiation alone: 14 cases

4 survived 2 years:	28.6 per cent
2 survived 5 years:	14.3 per cent
All died of the disease	

Irradiation and nephrectomy: 14 cases

7 survived 2 years:	50.0 per cent
5 survived 5 years:	35.7 per cent

Of 14 patients treated solely with radiation, 4 survived two years, 2 survived five years, but all eventually died of the disease. Of 14 patients treated with radiation followed by nephrectomy, 7 survived two years and 5 survived five years. One of these 5 subsequently died without evidence of recurrent or metastatic neoplasm, but from causes directly related to the irradiation of metastasis.

It appears obvious from the above that although irradiation may hold the disease in abeyance for two or more years, nephrectomy is essential for a "cure."

Gross and Neuhauser[4] advocate immediate nephrectomy complemented by postoperative irradiation directed to the renal fossa. This is based on their observation of 47 per cent two-year "cure" by that method as compared with their result of 32 per cent "cure" for two years by operation alone. We are awaiting their report of five year studies on these cases. We have found metastatic lesions as late as forty-two months following treatment with preoperative irradiation and sixty-one months following irradiation alone. Furthermore, we deplore the application of irradiation unless there is definite evidence of residual neoplasm. We do not feel justified in subjecting a patient to postoperative irradiation unless residual neoplasm is known to be present, or is strongly suspected.

Once the diagnosis of Wilms' tumor has been established with reasonable certainty, we recommend starting radiation therapy immediately. Our plan consists of treating the tumor with 200 kv. radiation, 50 cm. focal skin distance, 0.9 or 1.9 mm. Cu half-value layer, directed to adequate anterior and posterior portals. For large tumors a lateral portal is added. We deliver 200 r in air to each of two portals, daily. The total air dose has ranged between 3,600 and 4,800 r, to provide a tumor dose of between 2,000 and 3,000 r. In the case of uncooperative patients we have not hestiated to use a rectally administered general anesthetic. Eight to twelve weeks following the beginning of the irradiation a nephrectomy is done. Following this we recommend examination at intervals of not longer than three months and include a roentgenogram of the chest for detection of metastasis to the lungs. In the event that pulmonary metastasis is discovered, irradiation is begun immediately. We deliver a tumor dose of approximately 1,000 r to the involved area.

SUMMARY

A plan of treatment for patients with Wilms' tumor consisting of irradiation followed by nephrectomy has been presented.

Four of the 14 patients so treated are alive and well from five to nine years.

A fifth patient lived 64 months before dying of causes directly related to the irradiation of pulmonary metastasis, although at autopsy no residual neoplasm was found.

We recommend energetic irradiation of metastatic foci and any recurrence of this disease.

Robert E. Flynn
550 W. Thomas Road
Phoenix, Arizona

REFERENCES

1. ALBARRAN, and IMBERT. Cited by LIEBERTHAL, F. Malignant tumors of kidney in childhood. *Surg., Gynec. & Obst.*, 1931, *53*, 77–88.
2. EWING, J. Neoplastic Diseases. Second edition. W. B. Saunders Company, Philadelphia, 1922.
3. FERRIS, D. O., and BEARE, J. B. Wilms' tumor; report of case with unusual postoperative metastasis. *Proc. Staff Meet., Mayo Clin.*, 1947, *22*, 94–98.
4. GROSS, R. E., and NEUHAUSER, E. B. D. Treatment of mixed tumors of kidney in childhood. *Pediatrics*, 1950, *16*, 843–852.
5. KERR, H. D. Treatment of malignant tumors of kidney in children. *J.A.M.A.*, 1939, *112*, 408–411.
6. KRETSCHMER, H. L. Adenomyosarcoma of kidney (Wilms' tumor). *Arch. Surg.*, 1940, *41*, 370–384.
7. MASSON, P. Role of neural crests in embryonal adenosarcomas of kidney. *Am. J. Cancer*, 1938, *33*, 1–32.
8. MCDONALD, J. R., and PRIESTLEY, J. T. Malignant tumors of kidney. *Surg., Gynec. & Obst.*, 1943, *77*, 295–306.
9. *Metropolitan Bull.*, 1949, *30*, 5.
10. NICHOLSON, G. W. Embryonic tumour of kidney in foetus. *J. Path. & Bact.*, 1931, *34*, 711–730.
11. WU, S. D., *Chinese M. J., Supp. II.*, 1938, 193.

A SIMPLE APPROACH TO THE ROENTGEN DIAGNOSIS OF ABDOMINAL TUMORS IN INFANTS AND CHILDREN*

By CHARLES M. NICE, JR., M.D., ALEXANDER R. MARGULIS, M.D., *and* LEO G. RIGLER, M.D.

THE palpation of an abdominal mass by the parents, family physician or pediatrician in a symptomatic or asymptomatic infant often leads to exploratory laparotomy following little other than the obtaining of simple roentgenograms of the abdomen. Such masses include benign and malignant tumors, cysts, abscesses, intussusception and miscellaneous cyst-like lesions such as hydronephrotic kidneys and hydrometrocolpos.

Attempts have been made to differentiate solid from cystic masses[33] and to detect features of specific organal enlargement or of specific disease entities. Various nonspecific, characteristic and specific signs have been described.

Several articles have appeared during the past three decades describing the roentgen features of extra-alimentary masses in adults,[3,6,10,22,26,32] and Capurro and Blanco[8] have published an extensive monograph, in Spanish, on the topographic approach to localization of abdominal masses in adults. Wilson[33] summarized considerable information concerning abdominal cysts in infants and children. Several basic principles established in these writings have been utilized in forming a relatively simple approach to the roentgen diagnosis of abdominal masses in infants and children.

DESCRIPTION OF METHOD

The history and physical examination may yield important data concerning the location, nature and pathogenesis of any given abdominal mass. For example, on physical examination a cystic lesion may be fluctuant, a fluid wave may be elicited, or fluid may be aspirated. Roentgenographically, cystic lesions may be characterized by sharp, smooth borders, may change in size rapidly, and the contour may be altered by the position of the patient.[33]

In the roentgen analysis of abdominal masses in children, as well as in adults, a basic principle is to attempt to determine whether the mass is intraperitoneal or extraperitoneal. Quite often this is possible with the aid of simple anteroposterior and lateral views of the abdomen. Contrast studies of the urinary and gastrointestinal tracts are of value in rendering a more precise localization. The use of the lateral view[4] is stressed both in simple roentgenography and in contrast studies.[11] Occasionally the use of more complicated procedures, such as pneumoperitoneum and gastric or presacral air insufflation, may be indicated to obtain additional data.

If the mass is intraperitoneal an attempt is made to determine whether it is intimately connected with the liver or spleen. If the mass is extraperitoneal attention should be concentrated upon differentiating renal and adrenal masses from other tumefactions. The diagnostic importance of these corollaries is based not only on the incidence of tumors in the organs named, but also upon the relative precision with which masses may be localized in these organs.

Following careful topographic analysis a search is made for further signs which may indicate the organ involved or the nature of the mass itself. Examples of such clues are the characteristic duodenal displacements produced by choledochal or pancreatic cysts, or the presence of calcification, teeth or radiolucent layering in dermoid cysts.

Correlation with clinical, laboratory and other roentgenographic data may be regarded as another step in obtaining a more precise localization or more exact diagnosis.

* From the Department of Radiology, University of Minnesota Medical School, Minneapolis 14, Minnesota.

If the patient has a hemangioma elsewhere, an intra-abdominal mass, especially if it contains calcification, may likely represent another hemangioma. If a mass is present in the adrenal region, and other roentgen or clinical signs of prematurity are found, a diagnosis of adenoma or adenocarcinoma of the adrenal cortex is indicated.

To summarize, this method of roentgen diagnosis of abdominal masses in infants and children is based on careful topographic analysis, general roentgen characteristics and relatively specific signs considered in the light of statistical probability.

TOPOGRAPHIC CLASSIFICATION

A precise knowledge of the peritoneal reflections is necessary in differentiating intraperitoneal from extraperitoneal masses. The following topographic classification of abdominal masses in infants and children is suggested:

I. Intraperitoneal masses.
   1. Masses in the regions of the liver and spleen.
   2. Other intraperitoneal masses.

II. Extraperitoneal masses.
   1. Masses of the renal and adrenal regions.
   2. Other extraperitoneal masses.

It is obvious that a more detailed topographic classification could be formed. Specific topographic signs will be cited in various disease processes discussed below.

MASSES IN THE REGION OF THE LIVER AND SPLEEN

When masses occur in the liver, the roentgen signs may vary with the lobe or lobes involved. When the right hepatic lobe is the predominant site of involvement, the hepatic shadow is enlarged in the right upper quadrant of the abdomen. In the lateral view a large portion of the roentgen opacity is located anteriorly. The stomach and duodenum are displaced to the left. The right kidney is depressed from its anterior surface and the renal outline may be seen clearly on the plain anteroposterior

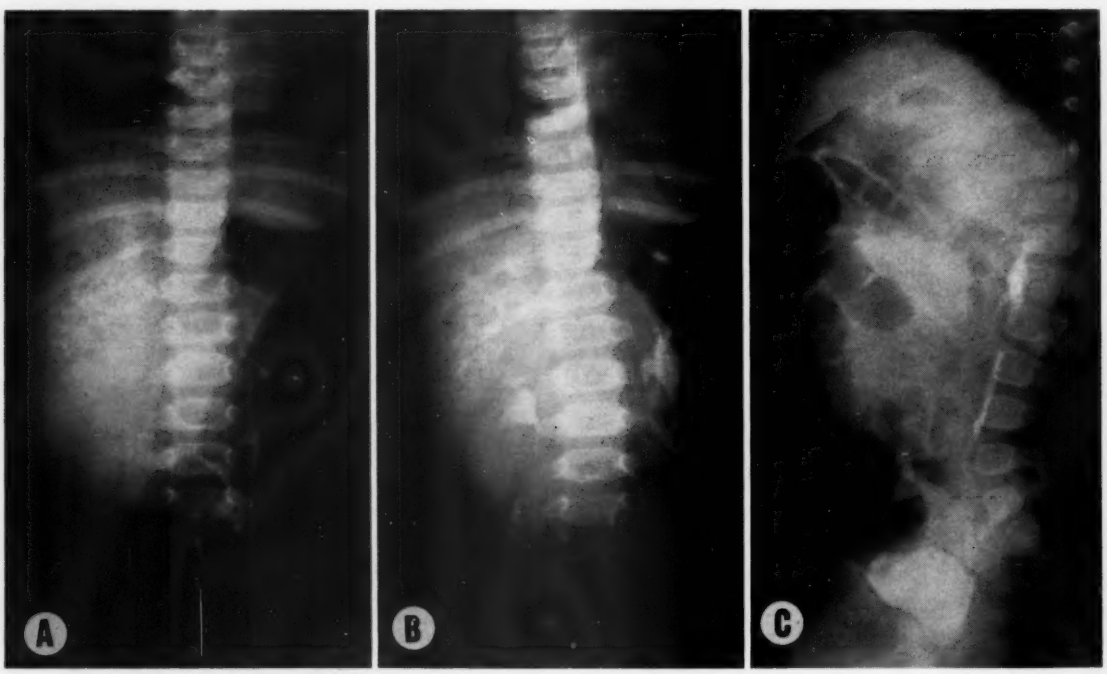


FIG. 1. Hepatoma of right lobe of liver. (Reproduced from *Radiology* by permission). (*A*) Large mass in right upper quadrant, containing calcification; inseparable from liver, clearly separable from kidney; stomach and small intestine displaced to left. (*B*) Excretory urogram showing slight downward and medial displacement of right kidney. (*C*) Lateral urogram showing anterior displacement of right kidney; duodenal loop and region of duodenojejunal junction in normal position.

film or during excretory urography. If the posterior portion of the liver is involved the right kidney may be displaced downward. The hepatic flexure of the colon is displaced downward and usually posteriorly (Fig. 1).

Enlargement of the left lobe of the liver results in increased roentgen opacity of the hepatic shadow in the left upper quadrant of the abdomen. The fundus of the stomach is displaced to the left, downward or anteriorly (Fig. 2).

General involvement of the liver produces a combination of the above signs. The hepatic shadow is generally enlarged, and the stomach, duodenum, small intestinal loops, hepatic flexure and transverse colon are all displaced downward and to the left.

The predominant hepatic tumor in infants and small children is the embryonal hepatoma.[21] Other less common hepatic tumors include the hepatic cyst, adenoma, hamartoma, single or multiple hemangiomata, hemangioendothelioma, lymphangioma, myxosarcoma and sarcoma.[14]

The symptoms and signs of embryonal hepatoma, as with most hepatic tumors, depend on the site, size and rapidity of growth of the lesion. Abdominal discomfort, failure to develop properly and other nonspecific symptoms may be noted. Very few of the patients have jaundice. The palpation of an abdominal mass by the parents may be the presenting complaint.

The roentgen signs of embryonal hepatoma have been reviewed by Margulis, *et al.*[21] Briefly, there is usually a large mass occurring in either or both lobes of the liver; the roentgen opacity is inseparable from the liver, but is definitely separate from the kidneys, which may or may not be displaced by it. The liver edge is undulating at times. The gastrointestinal structures are displaced away from the predominant area of enlargement. The duodenojejunal junction, the ascending and descending colon, and the kidneys are never displaced anteriorly. Occasionally, calcification is seen in the hepatic tumor.

In general, other tumors of the liver

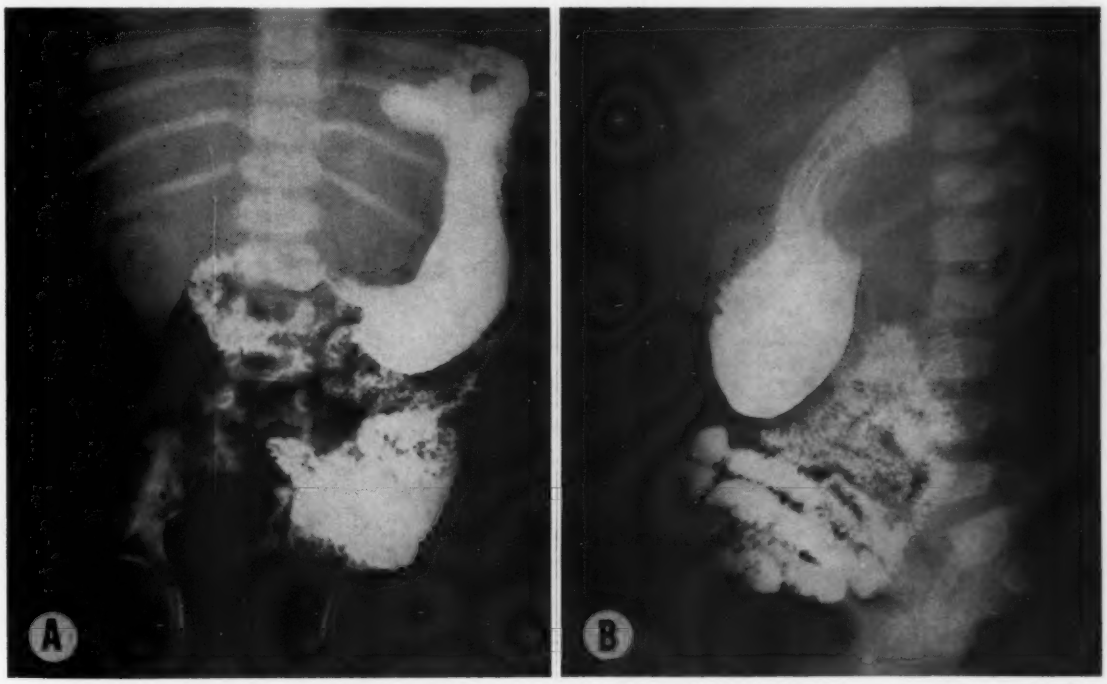


Fig. 2. Hepatoma of left lobe of liver. (Reproduced from *Radiology* by permission.) (*A*) Mass in upper central abdomen displacing barium-filled stomach and duodenal bulb to left; duodenal loop in relatively normal position. Renal outline seen through mass, in normal position. (*B*) Lateral view shows indentation of posterior wall of stomach. Duodenojejunal junction in normal position.

cannot be differentiated from embryonal hepatoma by this method. If there is a known hemangioma elsewhere in the patient, or if there are small calcifications resembling phleboliths, a hemangioma of the liver may be suspected. Extreme enlargement of the liver with great upward displacement of intestinal shadows may cause one to suspect hepatic sarcoma. A large hepatic cyst causes enlargement of the hepatic roentgen opacity; the margin is rounded and clearly defined (Fig. 3).

Hepatic enlargement also occurs in many other conditions[7] in childhood, such as fatty infiltration, congestion, cirrhosis, hepatitis, abscess, metastatic neoplasm, reticuloses, carbohydrate storage disease and congestive splenomegaly (Banti's disease). The roentgen demonstration of hepatic enlargement must be correlated with other findings in these conditions.

Choledochal cyst is seen clinically as a mass in the right upper quadrant, occurring in a jaundiced infant. Roentgenographically, it may be seen as a rounded opacity forming a characteristic impression on the posterolateral aspect of the second portion of the duodenum. When this picture is produced the cyst is retroperitoneal (Fig. 4).

In infants and children the spleen is enlarged in hemolytic anemia, traumatic rupture, acute and chronic bacteremias (syphilis, tuberculosis and bacterial endocarditis), reticuloendotheliosis, leukemia, rheumatoid arthritis, amyloid disease, osteopetrosis and in the rare tumors and cysts of the spleen.[7] The enlarged spleen may indent the greater curvature of the stomach or depress the splenic flexure of the colon. In most instances the left kidney is not displaced, but occasionally the greatly enlarged spleen may displace the kidney downward and medially.[12,15,29] A retroperitoneal abscess in the left upper quadrant may displace the upper part of the descend-

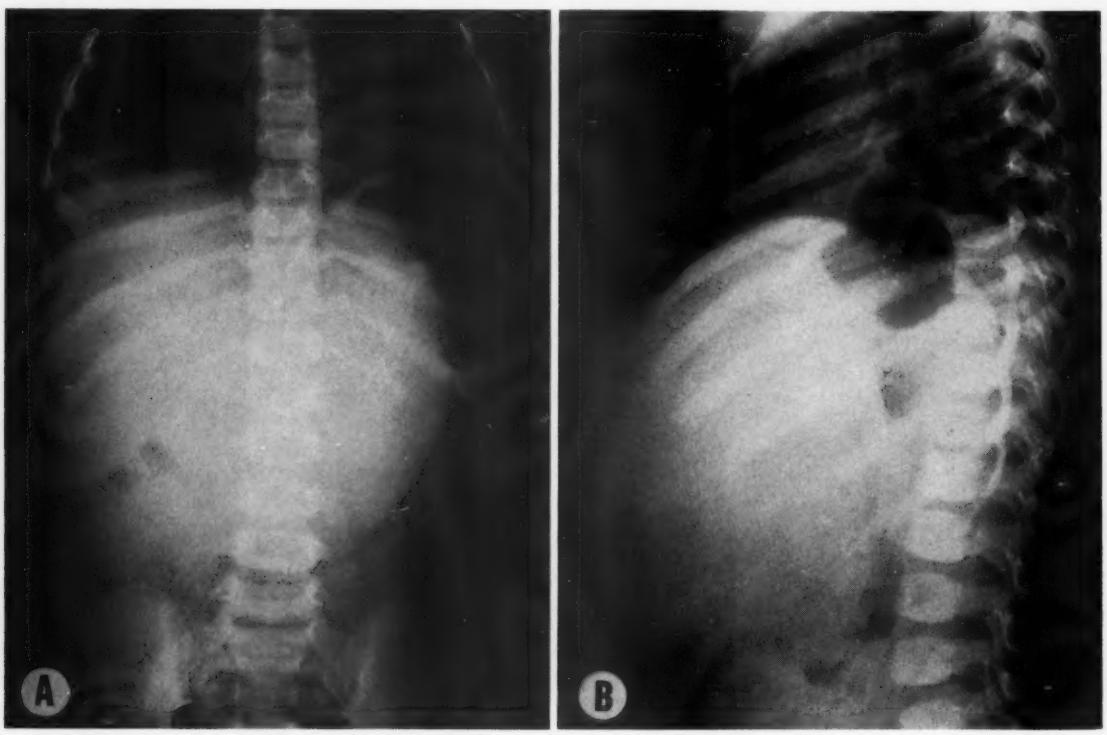


FIG. 3. Hepatic cyst. (Reproduced from *Radiology* by permission.) (*A* and *B*) The anteroposterior and lateral films of abdomen show characteristics of mass associated with liver; the margin is clearly outlined; compare with Figures 1 and 2.

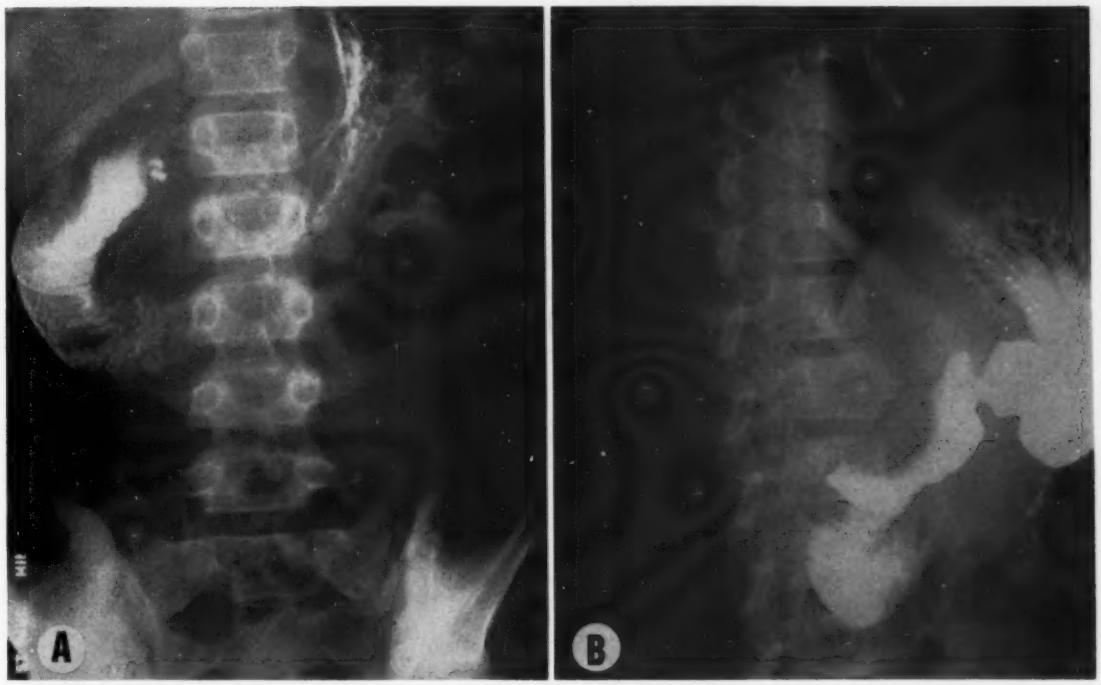


Fig. 4. Choledochal cyst. (*A* and *B*) Characteristic indentation on posterolateral aspect of descending portion of duodenum.

ing colon and the duodenojejunal junction anteriorly, but these almost never occur with an enlarged spleen.

OTHER INTRAPERITONEAL MASSES

Intrinsic lesions of the alimentary canal are usually diagnosed with the aid of appropriate contrast studies. Extra-alimentary masses of intraperitoneal origin displace or impinge upon various intestinal loops. The kidneys and ureters are not significantly displaced unless the mass is quite large, and complete ureteral obstruction is rare. In lateral views the anterior relationship of the mass is apparent.

Mesenteric and omental cysts are derived from lymphatic channels and are separate from the intestinal wall. They differ chiefly in anatomic location. The mesenteric cyst (Fig. 5) is seen in the course of the mesocolon or the root of the mesentery,[17] and, at times, two apparent masses forming a dumbbell shape may occur.[33] This cyst may calcify and rarely there may be multiple mesenteric cysts.[14] In the lateral view the omental cyst is seen just posterior to the anterior abdominal wall.

A cyst of the middle portion of the omphalomesenteric or vitelline duct[33] results in the formation of a subumbilical cystic mass. Persistence of the proximal portion of the vitelline duct results in the formation of Meckel's diverticulum in the distal ileum. Occasionally the latter anomaly is visualized as a pocket containing gas[20] or barium.

The enterogenous cyst, or alimentary duplication, usually has one portion of its wall in continuity with the intestinal wall, although it is unusual for the interior of the cyst to communicate with the lumen of the bowel.[14,33] This factor of mural continuity may cause the cyst to encroach upon the intestinal wall, leading to partial intestinal obstruction, or may cause interference with the common blood supply with production of necrosis and hemorrhage. Barium studies may demonstrate that the mass is adjacent to an area of partial obstruction. The barium study is not always necessary (Fig. 6).

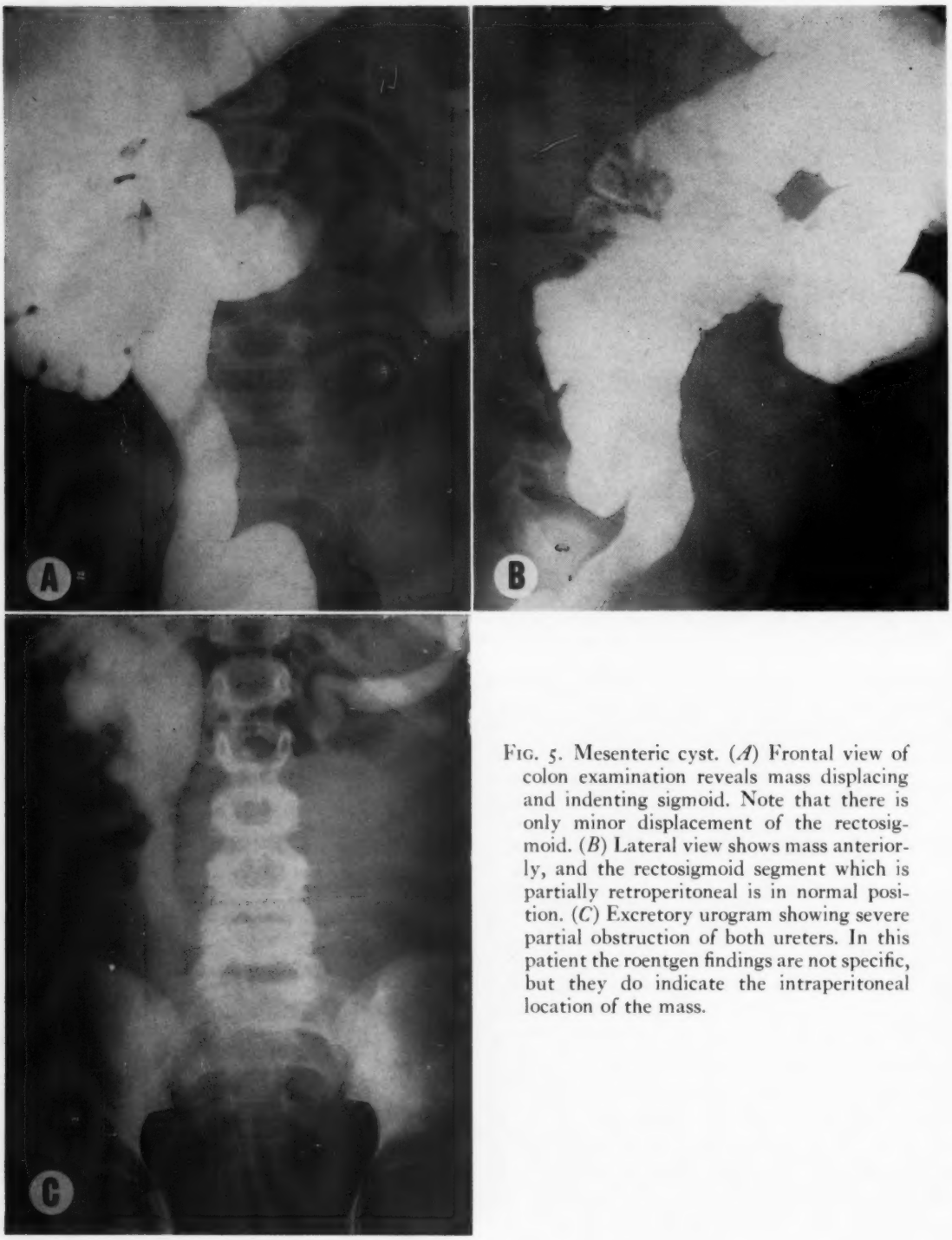


FIG. 5. Mesenteric cyst. (*A*) Frontal view of colon examination reveals mass displacing and indenting sigmoid. Note that there is only minor displacement of the rectosigmoid. (*B*) Lateral view shows mass anteriorly, and the rectosigmoid segment which is partially retroperitoneal is in normal position. (*C*) Excretory urogram showing severe partial obstruction of both ureters. In this patient the roentgen findings are not specific, but they do indicate the intraperitoneal location of the mass.

An appendiceal abscess is seen as a rather poorly defined opaque area in the right lower abdominal quadrant. Small bubbles of gas may be seen within the abscess, and an indentation of the contiguous intestine may be present. Signs of local or generalized peritoneal irritation, or of partial intestinal obstruction also

occur. Abscesses may occur in other intraperitoneal and extraperitoneal locations in the abdomen and pelvis. Usually these may be suspected by analyzing the local signs of abscess and displacement of neighboring structures.

Intussusception is identified as a mass protruding into the intestinal lumen, usually in the ileum, ascending or proximal transverse colon, with obstruction proximal to the mass. Contrast enema demonstrates the so-called "coiled spring" effect produced by the entrance of the contrast substance into the narrow space between the intussusceptum and intussuscipiens.

Teratomas and dermoid cysts of the ovary occur in the pelvis, in most cases slightly to one side of the midline, and very frequently show characteristic calcification, dental structures or radiolucent layering in the upright position[19] which is attributed to the presence of fatty or sebaceous material (Fig. 7).

Lymphangioma of the intestine and mesentery is a rare condition which may follow an extensive course through the mesentery and associated intestine. The intestinal loops are separated and their walls thickened. This process may simulate ascites, from which it is differentiated by positioning, the presence of narrowed intestinal lumen, and by the presence of lymphangiomas elsewhere in the patient (Fig. 8).

Fig. 6. Duplication cyst of small bowel. This case illustrates how careful analysis of a single film may reveal a sharply outlined mass separate from liver and kidney, displacing intraperitoneal structures only, and producing partial intestinal obstruction; these findings usually indicate an alimentary duplication cyst.

MASSES OF THE RENAL AND ADRENAL REGION

These retroperitoneal tumefactions displace the intraperitoneal structures, such as small intestinal loops, in an anterior direction and to either side. In addition, they may also displace retroperitoneal structures in any direction. Some form of retroperitoneal growth is necessary to displace anteriorly the duodenojejunal junction,[4,8] ascending colon and descending colon, or to cause complete ureteral obstruction.

Wilms' tumor is the most common tumor of the abdomen in childhood.[14] On plain roentgenograms a mass is seen arising in either renal area, displacing intestinal loops anteriorly and to either side. Calcification of nonspecific character may be noted. Urographic studies reveal that the calyces are distorted and may be invaded by tumor tissue. The renal pelvis may be relatively normal, or may be compressed or elongated. Further, the renal pelvis may appear to "ride" at the upper or lower pole of the tumor, and may be displaced medially, anteriorly or posteriorly. Nonvisualization is rare. The upper portion of the ureter may be displaced medially (Fig. 9, 10, 11). Renal carcinoma is indistinguishable by this method from Wilms' tumor but is very rare in infancy and childhood.

A renal cyst is seen as a smooth round mass which may displace but never in-

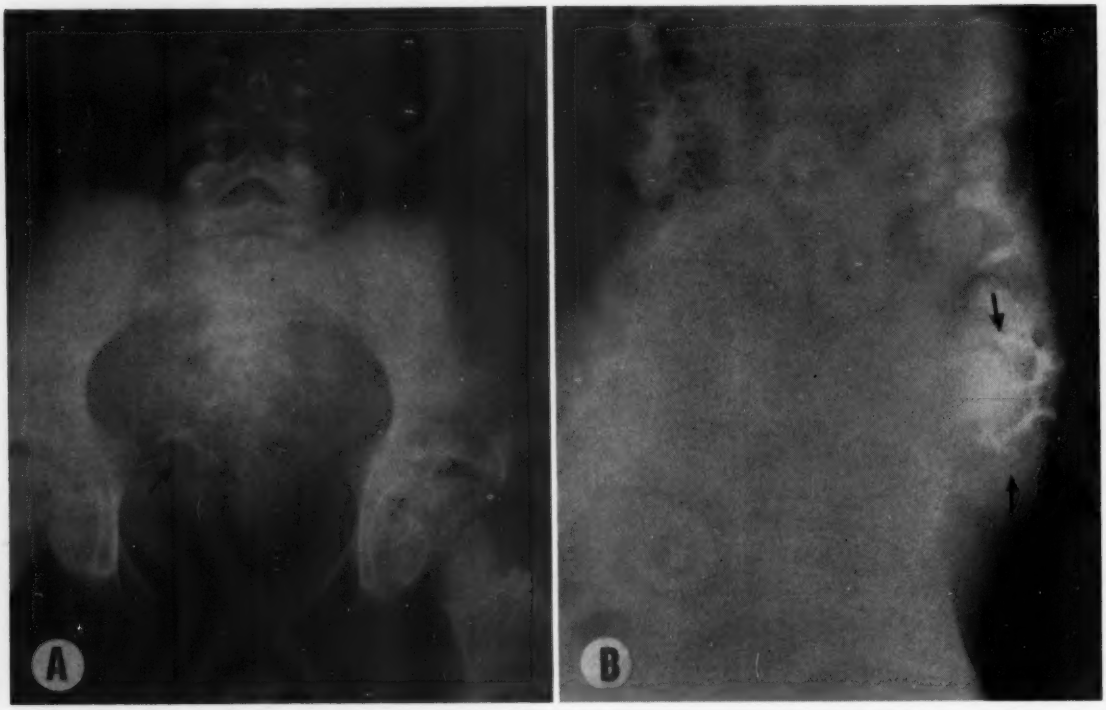


FIG. 7. Ovarian teratoma. (*A*) Pelvic mass with calcification suggesting cystic structure (arrow). (*B*) Lateral view indicates mass is intraperitoneal (arrows). These findings are characteristic, and almost specific.

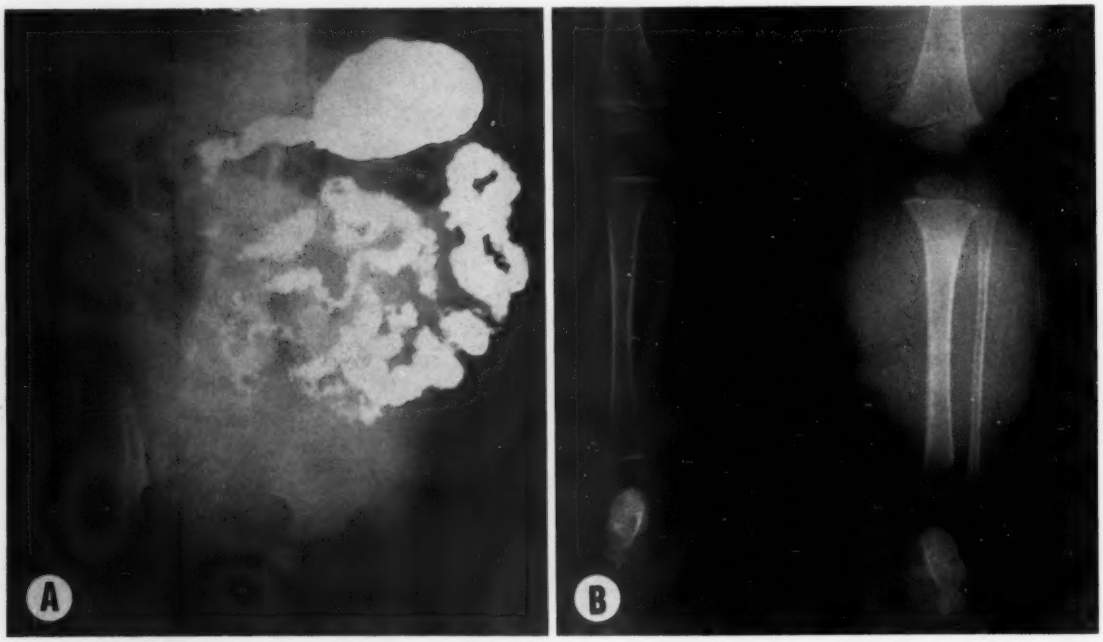


FIG. 8. Lymphangioma of mesentery, small intestine and abdominal wall. (*A*) Oral barium study reveals separated loops of small intestine which have thickened wall and narrowed lumen. (*B*) Lymphangioma of left thigh and leg.

Fig. 9. Wilms' tumor of left kidney. (*A*) Excretory urogram shows large mass inseparable from kidney, which is nonfunctioning (unusual). (*B*) Left retrograde pyelogram reveals extreme distortion of renal pelvis and calyces.

Fig. 10. Wilms' tumor of left kidney. (*A*) Calcification in large mass. (*B*) Excretory urogram confirms that calcification is within left kidney. Medial displacement of renal pelvis with hydronephrosis.

vades the calyces (Fig. 12). Polycystic kidneys produce bilateral enlargement with rounded indentations in the calyces on the urogram. Usually these patients die early in infancy, or the condition does not become clinically apparent until adult life. Bilateral renal enlargement with somewhat similar distortion of the calyces suggests leukemic infiltration.[13]

Neuroblastoma sympathicum is probably the second most common abdominal tumor in infants.[14] It arises from the adrenal medulla (Fig. 13, 14) or from extra-adrenal portions of the chromaffin system (Fig. 15), and is highly malignant. Calcification is rather common.[24] We have seen one patient with extensive calcification both in the primary tumor and in metastases (Fig. 21). The neuroblastoma grows rapidly and

FIG. 11. Wilms' tumor of right kidney. Excretory urogram shows extreme distortion of upper pole; the diffuse nature of the calyceal involvement tends to differentiate this from adrenal neuroblastoma.

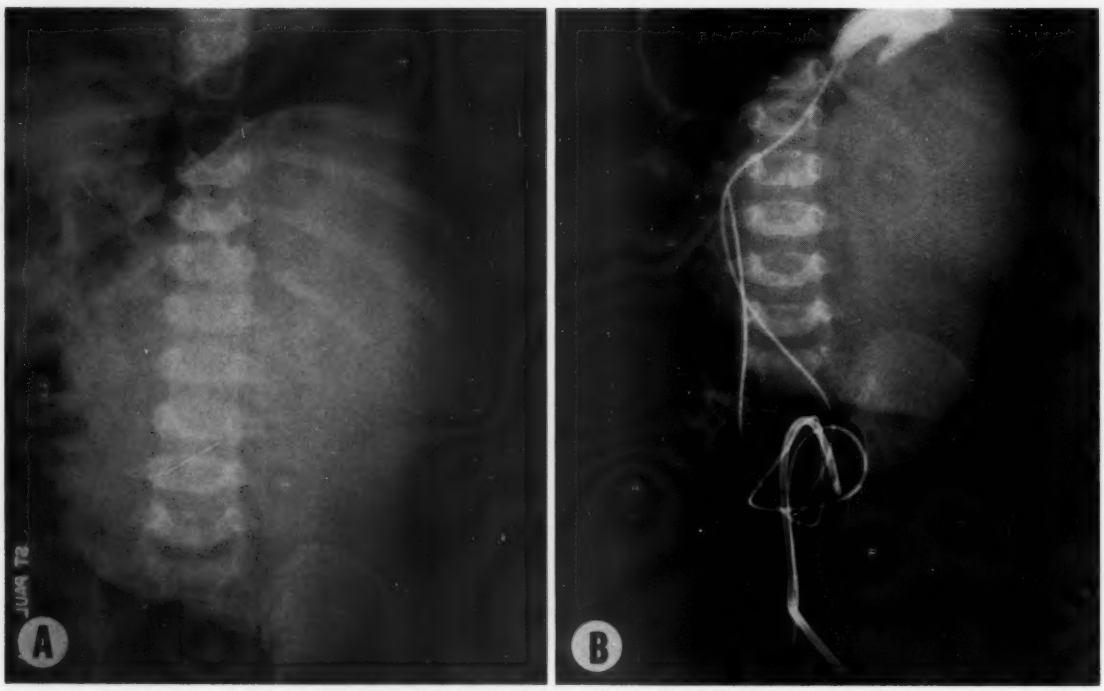


FIG. 12. Solitary renal cyst. (*A*) Large sharply outlined mass predominantly in left abdomen. Left renal outline not visible. (*B*) Left retrograde urogram shows upward displacement of renal pelvis by a rounded mass within the kidney.

is highly invasive. Arising on either side of the vertebral column, it may extend to the other side or even invade the vertebral bodies or pedicles.[14] Plain roentgenograms show anterior and centrifugal displacement of intestinal loops. The tumor may extend behind the duodenojejunal junction as well as other retroperitoneal structures. In contrast urography the kidney is displaced downward and sometimes laterally. This tumor metastasizes widely to the liver, skeleton, skull, brain and lungs, a distribution which differs from that of Wilms' tumor. Skeletal metastases may simulate leukemic infiltration; any spicule formation favors the diagnosis of neuroblastoma, whereas involvement of the distal third of the extremities favors leukemia.[14]

Other adrenal medullary tumors include the benign ganglioneuroma and the pheochromocytoma, both much less common than neuroblastoma in children. The latter tumor secretes an epinephrine-like substance which gives rise to an intermittent or continuous hypertension.

Fig. 13. Neuroblastoma of left adrenal. Retrograde urogram shows mass with calcification (arrow) producing downward and lateral displacement of the left kidney. The mass extends across the midline and rotates the right kidney, and also displaces the ureteropelvic juncture, producing hydronephrosis.

Fig. 14. Neuroblastoma of left adrenal. Retrograde urogram reveals downward and lateral displacement of the left kidney without intrinsic deformity of the renal pelvis or calyces.

Adrenal cortical tumors, adenoma and carcinoma give rise to masculinization and advanced skeletal development (Fig. 16).

With the above discussion firmly in mind it is possible, in the majority of patients, to distinguish renal and adrenal masses, and often to make a specific diagnosis.

OTHER EXTRAPERITONEAL MASSES

Retroperitoneal teratoma is the third most common retroperitoneal tumor of childhood.[1,16,23] This tumor occurs most frequently in the sacrococcygeal area and next most frequently in the paravertebral gutter.[23] Those of the latter group generally arise rather high in the abdomen, close to

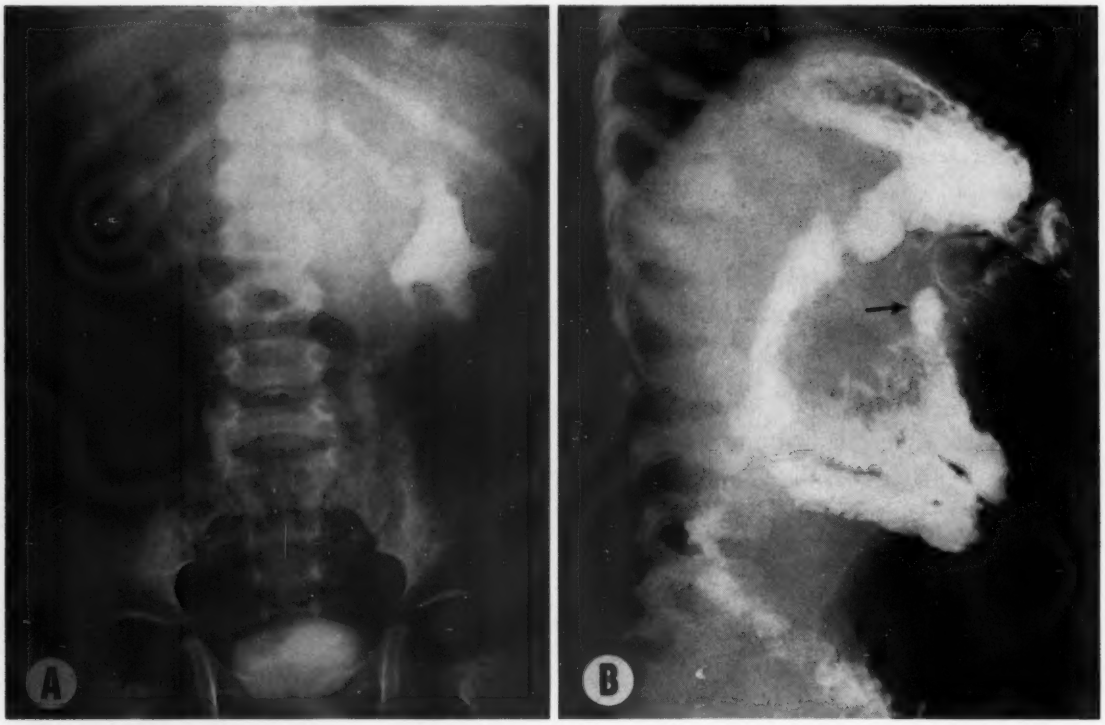


FIG. 15. Neuroblastoma arising in extra-adrenal chromaffin tissue. (*A*) Retroperitoneal mass displacing left kidney and upper ureter to left. (*B*) Lateral view after barium meal reveals anterior dislocation of duodenojejunal (arrow) as well as of intraperitoneal alimentary structures. Differential diagnosis would include pancreatic tumor and retroperitoneal lymphoma.

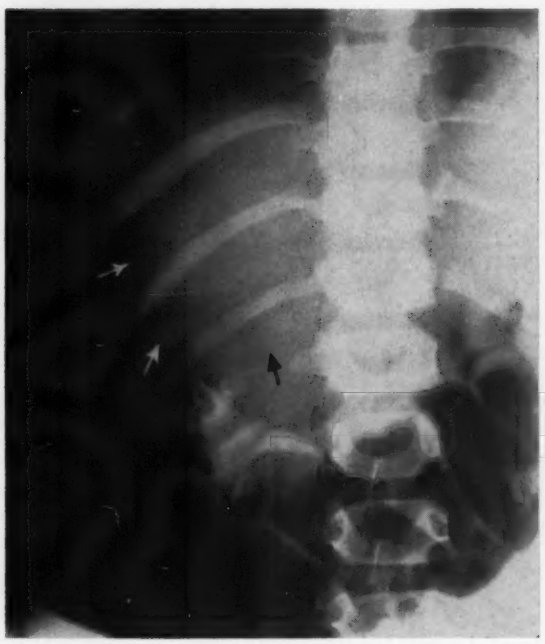


FIG. 16. Carcinoma of adrenal cortex. Ill-defined mass causing downward displacement of right kidney (arrows). This three year old child had skeletal development of a nine year old.

FIG. 17. Retroperitoneal teratoma (included twin). The pronounced displacement of both the ascending and descending colon indicates retroperitoneal location.

the pancreas and kidneys. They may lie entirely to one side of the midline, but many bulge beyond the spinal column. The tumor is particularly apt to be detected in the first months of life, more than one-half being seen in the first year, and about two-thirds being seen in the first two years. Roentgenographically, a mass is seen displacing the small intestinal loops anteriorly and centrifugally. A very high proportion show some irregular calcification, which may be spotty or simulate mature osseous formation. An extreme degree of differentiation[27] is known as included twin or *fetus in fetu* (Fig. 17). Urography reveals displacement of the ipsilateral kidney and hydronephrosis may be caused by pressure on a ureter. Extensive distortion and invasion of the renal pelvis and calyces does not occur, thus differing from Wilms' tumor. Rarely, retroperitoneal pneumography may be required to show that the teratoma is unattached to other structures.

Pancreatic cysts, pseudocysts and the relatively rare cystadenocarcinoma of the pancreas give rise to a variety of topographic configurations. Several authors[9,30,33] list and illustrate the following:

1. Cyst of head of pancreas enlarging the duodenal loop.
2. Gastrohepatic type, enlarging between the lesser curvature of the stomach and the liver.
3. Gastrocolic type, enlarging between the stomach and transverse colon.
4. Gastrosplenic type, enlarging between the stomach and splenic flexure.
5. Gastrocolic type, enlarging between the stomach and distal transverse colon.
6. Mesocolic type, enlarging into the mesocolon and below the transverse colon.

The most common is the gastrocolic type which enlarges between the stomach and

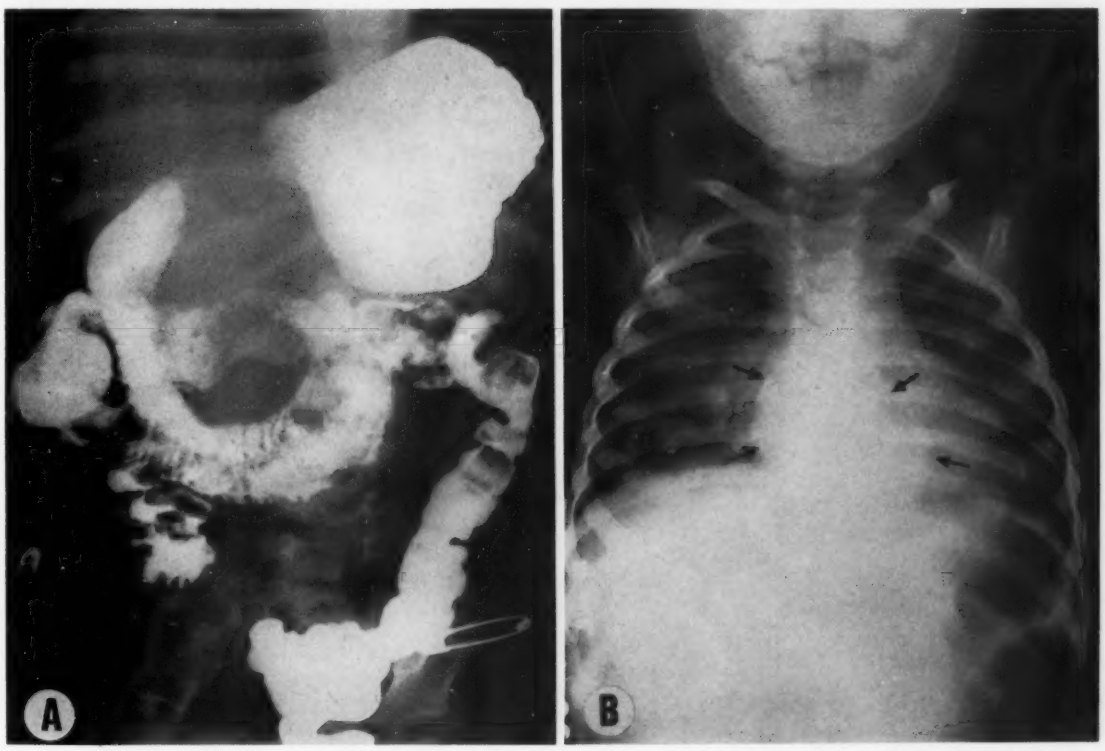


Fig. 18. Retroperitoneal lymphoma. (*A*) Enlargement of duodenal loop and separation of stomach from colon, similar to pancreatic mass. (*B*) Involvement of mediastinal lymph nodes (arrows) tends to confirm the diagnosis of lymphoma.

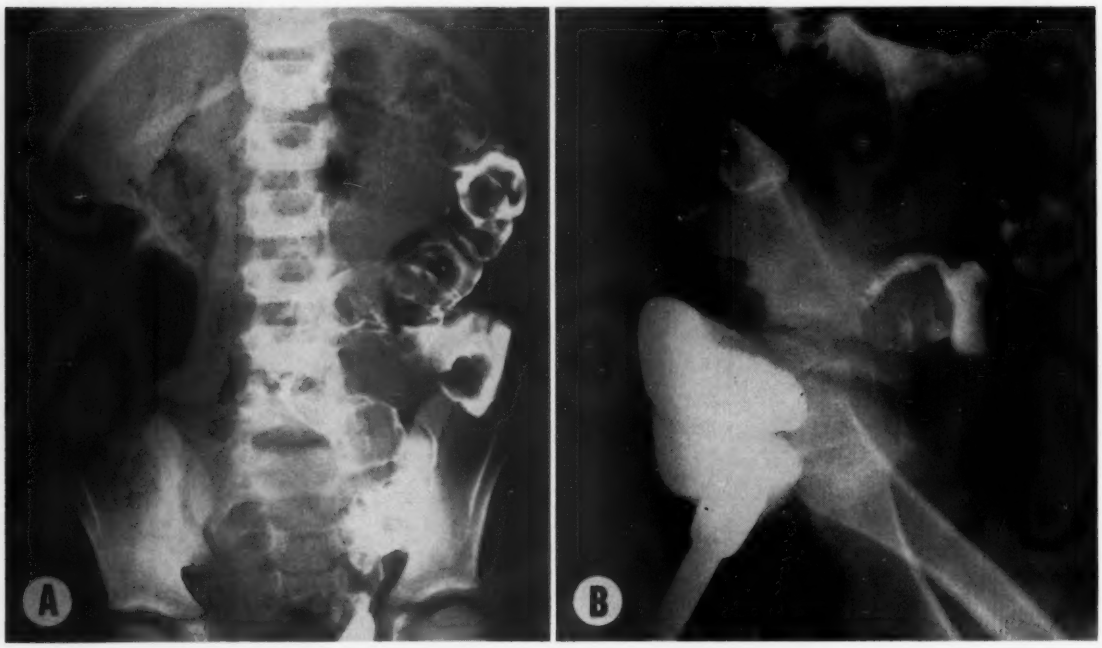


FIG. 19. Retroperitoneal fibrosarcoma arising in pelvic region. (*A*) Barium enema study reveals displacement of rectosigmoid junction to left. (*B*) Lateral view shows anterior displacement of rectosigmoid junction, indicating retroperitoneal location of mass. Compare with Figure 5.

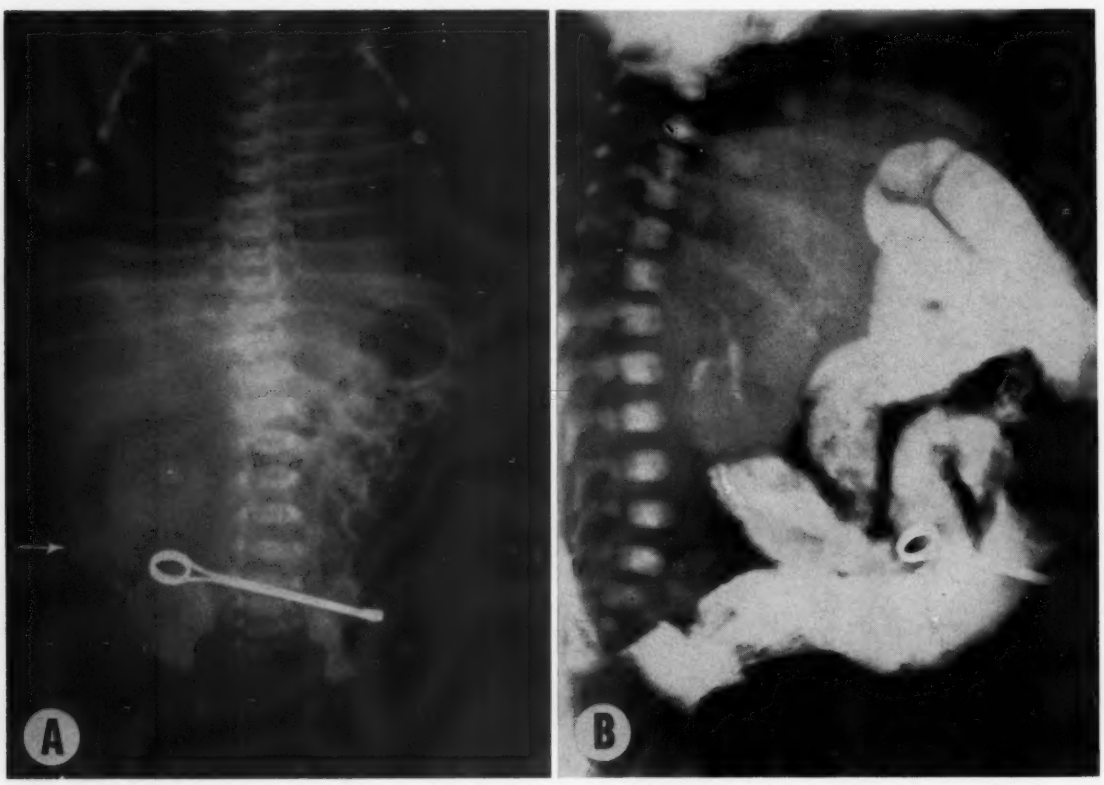


FIG. 20. Retroperitoneal cavernous hemangioma. (*A*) Mass in right side of abdomen with non-characteristic calcification (arrow). (*B*) Mass is retroperitoneal, displacing ascending colon forward. Kidneys are functioning well in normal position and are separate from the mass. (Reproduced from *Minnesota Medicine* by permission.)

speculate that had a nephrectomy been performed in this case would metastasis have developed?

Case 14 is the only operative death.

Case 20 demonstrates complete disappearance of metastatic lesions following treatment by radiation. The fact that this patient died as a result of infection superimposed on the pulmonary damage produced by the irradiation is disheartening. However, with the present day management of chronically infected lung with antibiotics and thoracic surgery, as well as the possibility of preventing radiation injury with cortisone and dicumeral, a similar unfortunate circumstance might be averted.

Cases 21, 23, 24 and 25 are alive and well, 109, 96, 72, and 70 months respectively following preoperative irradiation and nephrectomy. It is of interest that each of these five year survivals was less than two years old when treated. The observation that those in whom the lesion is discovered before the age of two appear to have a better prognosis is confirmed by our experience.

Of the 28 cases, 11 survived two years and 7 were still alive after 5 years. Two of the 7 (Cases 5 and 9) died of the disease after five years and one (Case 20) died as a result of irradiation of pulmonary metastasis.

It is interesting to compare the length of survival of those treated with radiation alone to those treated with radiation followed by nephrectomy.

Irradiation alone: 14 cases

4 survived 2 years:	28.6 per cent
2 survived 5 years:	14.3 per cent
All died of the disease	

Irradiation and nephrectomy: 14 cases

7 survived 2 years:	50.0 per cent
5 survived 5 years:	35.7 per cent

Of 14 patients treated solely with radiation, 4 survived two years, 2 survived five years, but all eventually died of the disease. Of 14 patients treated with radiation followed by nephrectomy, 7 survived two years and 5 survived five years. One of these 5 subsequently died without evidence of recurrent or metastatic neoplasm, but from causes directly related to the irradiation of metastasis.

It appears obvious from the above that although irradiation may hold the disease in abeyance for two or more years, nephrectomy is essential for a "cure."

Gross and Neuhauser[4] advocate immediate nephrectomy complemented by postoperative irradiation directed to the renal fossa. This is based on their observation of 47 per cent two-year "cure" by that method as compared with their result of 32 per cent "cure" for two years by operation alone. We are awaiting their report of five year studies on these cases. We have found metastatic lesions as late as forty-two months following treatment with preoperative irradiation and sixty-one months following irradiation alone. Furthermore, we deplore the application of irradiation unless there is definite evidence of residual neoplasm. We do not feel justified in subjecting a patient to postoperative irradiation unless residual neoplasm is known to be present, or is strongly suspected.

Once the diagnosis of Wilms' tumor has been established with reasonable certainty, we recommend starting radiation therapy immediately. Our plan consists of treating the tumor with 200 kv. radiation, 50 cm. focal skin distance, 0.9 or 1.9 mm. Cu half-value layer, directed to adequate anterior and posterior portals. For large tumors a lateral portal is added. We deliver 200 r in air to each of two portals, daily. The total air dose has ranged between 3,600 and 4,800 r, to provide a tumor dose of between 2,000 and 3,000 r. In the case of uncooperative patients we have not hestiated to use a rectally administered general anesthetic. Eight to twelve weeks following the beginning of the irradiation a nephrectomy is done. Following this we recommend examination at intervals of not longer than three months and include a roentgenogram of the chest for detection of metastasis to the lungs. In the event that pulmonary metastasis is discovered, irradiation is begun immediately. We deliver a tumor dose of approximately 1,000 r to the involved area.

SUMMARY

A plan of treatment for patients with Wilms' tumor consisting of irradiation followed by nephrectomy has been presented.

Four of the 14 patients so treated are alive and well from five to nine years.

A fifth patient lived 64 months before dying of causes directly related to the irradiation of pulmonary metastasis, although at autopsy no residual neoplasm was found.

We recommend energetic irradiation of metastatic foci and any recurrence of this disease.

Robert E. Flynn
550 W. Thomas Road
Phoenix, Arizona

REFERENCES

1. ALBARRAN, and IMBERT. Cited by LIEBERTHAL, F. Malignant tumors of kidney in childhood. *Surg., Gynec. & Obst.*, 1931, *53*, 77–88.
2. EWING, J. Neoplastic Diseases. Second edition. W. B. Saunders Company, Philadelphia, 1922.
3. FERRIS, D. O., and BEARE, J. B. Wilms' tumor; report of case with unusual postoperative metastasis. *Proc. Staff Meet., Mayo Clin.*, 1947, *22*, 94–98.
4. GROSS, R. E., and NEUHAUSER, E. B. D. Treatment of mixed tumors of kidney in childhood. *Pediatrics*, 1950, *16*, 843–852.
5. KERR, H. D. Treatment of malignant tumors of kidney in children. *J.A.M.A.*, 1939, *112*, 408–411.
6. KRETSCHMER, H. L. Adenomyosarcoma of kidney (Wilms' tumor). *Arch. Surg.*, 1940, *41*, 370–384.
7. MASSON, P. Role of neural crests in embryonal adenosarcomas of kidney. *Am. J. Cancer*, 1938, *33*, 1–32.
8. MCDONALD, J. R., and PRIESTLEY, J. T. Malignant tumors of kidney. *Surg., Gynec. & Obst.*, 1943, *77*, 295–306.
9. *Metropolitan Bull.*, 1949, *30*, 5.
10. NICHOLSON, G. W. Embryonic tumour of kidney in foetus. *J. Path. & Bact.*, 1931, *34*, 711–730.
11. WU, S. D., *Chinese M. J., Supp. II.*, 1938, 193.

Vol. 75, No. 5

A SIMPLE APPROACH TO THE ROENTGEN DIAGNOSIS OF ABDOMINAL TUMORS IN INFANTS AND CHILDREN*

By CHARLES M. NICE, JR., M.D., ALEXANDER R. MARGULIS, M.D., *and* LEO G. RIGLER, M.D.

THE palpation of an abdominal mass by the parents, family physician or pediatrician in a symptomatic or asymptomatic infant often leads to exploratory laparotomy following little other than the obtaining of simple roentgenograms of the abdomen. Such masses include benign and malignant tumors, cysts, abscesses, intussusception and miscellaneous cyst-like lesions such as hydronephrotic kidneys and hydrometrocolpos.

Attempts have been made to differentiate solid from cystic masses[33] and to detect features of specific organal enlargement or of specific disease entities. Various nonspecific, characteristic and specific signs have been described.

Several articles have appeared during the past three decades describing the roentgen features of extra-alimentary masses in adults,[3,6,10,22,26,32] and Capurro and Blanco[8] have published an extensive monograph, in Spanish, on the topographic approach to localization of abdominal masses in adults. Wilson[33] summarized considerable information concerning abdominal cysts in infants and children. Several basic principles established in these writings have been utilized in forming a relatively simple approach to the roentgen diagnosis of abdominal masses in infants and children.

DESCRIPTION OF METHOD

The history and physical examination may yield important data concerning the location, nature and pathogenesis of any given abdominal mass. For example, on physical examination a cystic lesion may be fluctuant, a fluid wave may be elicited, or fluid may be aspirated. Roentgenographically, cystic lesions may be characterized by sharp, smooth borders, may change in size rapidly, and the contour may be altered by the position of the patient.[33]

In the roentgen analysis of abdominal masses in children, as well as in adults, a basic principle is to attempt to determine whether the mass is intraperitoneal or extraperitoneal. Quite often this is possible with the aid of simple anteroposterior and lateral views of the abdomen. Contrast studies of the urinary and gastrointestinal tracts are of value in rendering a more precise localization. The use of the lateral view[4] is stressed both in simple roentgenography and in contrast studies.[11] Occasionally the use of more complicated procedures, such as pneumoperitoneum and gastric or presacral air insufflation, may be indicated to obtain additional data.

If the mass is intraperitoneal an attempt is made to determine whether it is intimately connected with the liver or spleen. If the mass is extraperitoneal attention should be concentrated upon differentiating renal and adrenal masses from other tumefactions. The diagnostic importance of these corollaries is based not only on the incidence of tumors in the organs named, but also upon the relative precision with which masses may be localized in these organs.

Following careful topographic analysis a search is made for further signs which may indicate the organ involved or the nature of the mass itself. Examples of such clues are the characteristic duodenal displacements produced by choledochal or pancreatic cysts, or the presence of calcification, teeth or radiolucent layering in dermoid cysts.

Correlation with clinical, laboratory and other roentgenographic data may be regarded as another step in obtaining a more precise localization or more exact diagnosis.

* From the Department of Radiology, University of Minnesota Medical School, Minneapolis 14, Minnesota.

If the patient has a hemangioma elsewhere, an intra-abdominal mass, especially if it contains calcification, may likely represent another hemangioma. If a mass is present in the adrenal region, and other roentgen or clinical signs of prematurity are found, a diagnosis of adenoma or adenocarcinoma of the adrenal cortex is indicated.

To summarize, this method of roentgen diagnosis of abdominal masses in infants and children is based on careful topographic analysis, general roentgen characteristics and relatively specific signs considered in the light of statistical probability.

TOPOGRAPHIC CLASSIFICATION

A precise knowledge of the peritoneal reflections is necessary in differentiating intraperitoneal from extraperitoneal masses. The following topographic classification of abdominal masses in infants and children is suggested:

I. Intraperitoneal masses.
   1. Masses in the regions of the liver and spleen.
   2. Other intraperitoneal masses.

II. Extraperitoneal masses.
   1. Masses of the renal and adrenal regions.
   2. Other extraperitoneal masses.

It is obvious that a more detailed topographic classification could be formed. Specific topographic signs will be cited in various disease processes discussed below.

MASSES IN THE REGION OF THE LIVER AND SPLEEN

When masses occur in the liver, the roentgen signs may vary with the lobe or lobes involved. When the right hepatic lobe is the predominant site of involvement, the hepatic shadow is enlarged in the right upper quadrant of the abdomen. In the lateral view a large portion of the roentgen opacity is located anteriorly. The stomach and duodenum are displaced to the left. The right kidney is depressed from its anterior surface and the renal outline may be seen clearly on the plain anteroposterior

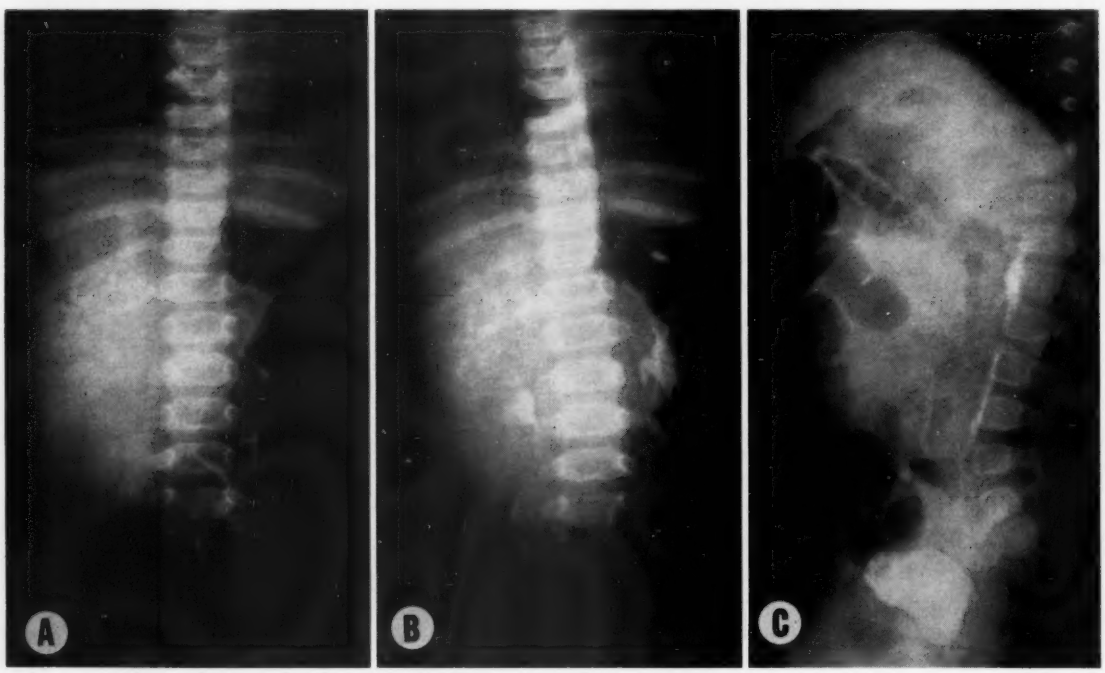


FIG. 1. Hepatoma of right lobe of liver. (Reproduced from *Radiology* by permission). (*A*) Large mass in right upper quadrant, containing calcification; inseparable from liver, clearly separable from kidney; stomach and small intestine displaced to left. (*B*) Excretory urogram showing slight downward and medial displacement of right kidney. (*C*) Lateral urogram showing anterior displacement of right kidney; duodenal loop and region of duodenojejunal junction in normal position.

film or during excretory urography. If the posterior portion of the liver is involved the right kidney may be displaced downward. The hepatic flexure of the colon is displaced downward and usually posteriorly (Fig. 1).

Enlargement of the left lobe of the liver results in increased roentgen opacity of the hepatic shadow in the left upper quadrant of the abdomen. The fundus of the stomach is displaced to the left, downward or anteriorly (Fig. 2).

General involvement of the liver produces a combination of the above signs. The hepatic shadow is generally enlarged, and the stomach, duodenum, small intestinal loops, hepatic flexure and transverse colon are all displaced downward and to the left.

The predominant hepatic tumor in infants and small children is the embryonal hepatoma.[21] Other less common hepatic tumors include the hepatic cyst, adenoma, hamartoma, single or multiple hemangiomata, hemangioendothelioma, lymphangioma, myxosarcoma and sarcoma.[14]

The symptoms and signs of embryonal hepatoma, as with most hepatic tumors, depend on the site, size and rapidity of growth of the lesion. Abdominal discomfort, failure to develop properly and other nonspecific symptoms may be noted. Very few of the patients have jaundice. The palpation of an abdominal mass by the parents may be the presenting complaint.

The roentgen signs of embryonal hepatoma have been reviewed by Margulis, *et al.*[21] Briefly, there is usually a large mass occurring in either or both lobes of the liver; the roentgen opacity is inseparable from the liver, but is definitely separate from the kidneys, which may or may not be displaced by it. The liver edge is undulating at times. The gastrointestinal structures are displaced away from the predominant area of enlargement. The duodenojejunal junction, the ascending and descending colon, and the kidneys are never displaced anteriorly. Occasionally, calcification is seen in the hepatic tumor.

In general, other tumors of the liver

Fig. 2. Hepatoma of left lobe of liver. (Reproduced from *Radiology* by permission.) (*A*) Mass in upper central abdomen displacing barium-filled stomach and duodenal bulb to left; duodenal loop in relatively normal position. Renal outline seen through mass, in normal position. (*B*) Lateral view shows indentation of posterior wall of stomach. Duodenojejunal junction in normal position.

cannot be differentiated from embryonal hepatoma by this method. If there is a known hemangioma elsewhere in the patient, or if there are small calcifications resembling phleboliths, a hemangioma of the liver may be suspected. Extreme enlargement of the liver with great upward displacement of intestinal shadows may cause one to suspect hepatic sarcoma. A large hepatic cyst causes enlargement of the hepatic roentgen opacity; the margin is rounded and clearly defined (Fig. 3).

Hepatic enlargement also occurs in many other conditions[7] in childhood, such as fatty infiltration, congestion, cirrhosis, hepatitis, abscess, metastatic neoplasm, reticuloses, carbohydrate storage disease and congestive splenomegaly (Banti's disease). The roentgen demonstration of hepatic enlargement must be correlated with other findings in these conditions.

Choledochal cyst is seen clinically as a mass in the right upper quadrant, occurring in a jaundiced infant. Roentgenographically, it may be seen as a rounded opacity forming a characteristic impression on the posterolateral aspect of the second portion of the duodenum. When this picture is produced the cyst is retroperitoneal (Fig. 4).

In infants and children the spleen is enlarged in hemolytic anemia, traumatic rupture, acute and chronic bacteremias (syphilis, tuberculosis and bacterial endocarditis), reticuloendotheliosis, leukemia, rheumatoid arthritis, amyloid disease, osteopetrosis and in the rare tumors and cysts of the spleen.[7] The enlarged spleen may indent the greater curvature of the stomach or depress the splenic flexure of the colon. In most instances the left kidney is not displaced, but occasionally the greatly enlarged spleen may displace the kidney downward and medially.[12,15,29] A retroperitoneal abscess in the left upper quadrant may displace the upper part of the descend-

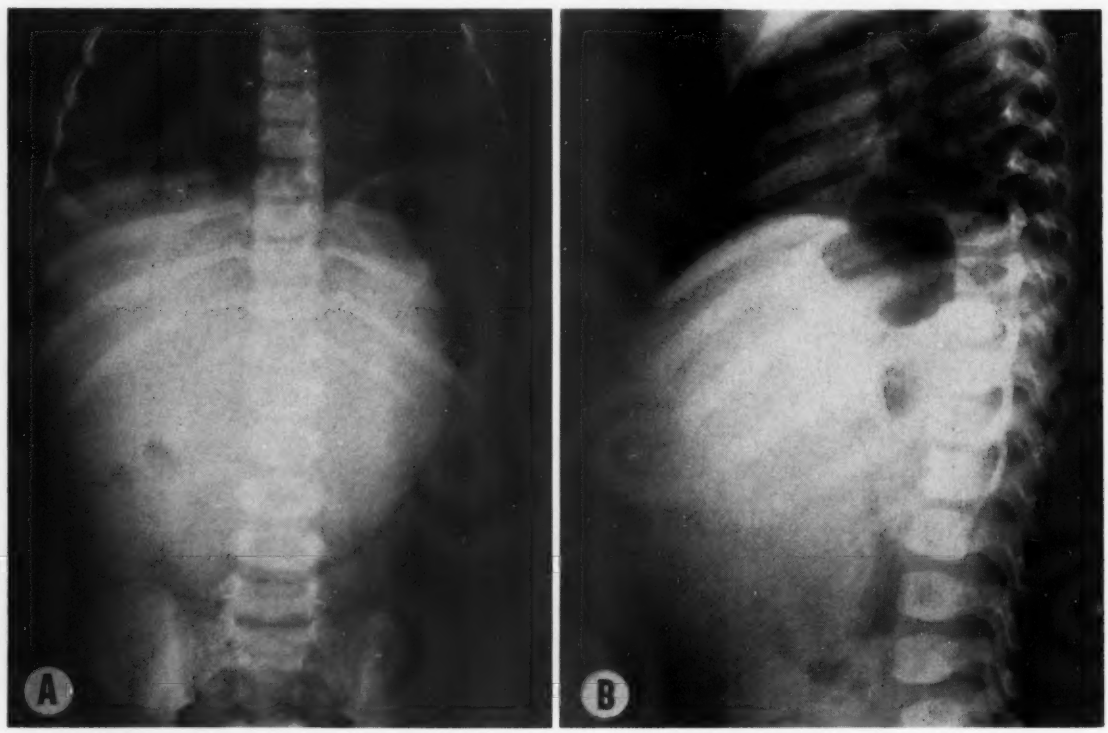


FIG. 3. Hepatic cyst. (Reproduced from *Radiology* by permission.) (*A* and *B*) The anteroposterior and lateral films of abdomen show characteristics of mass associated with liver; the margin is clearly outlined; compare with Figures 1 and 2.

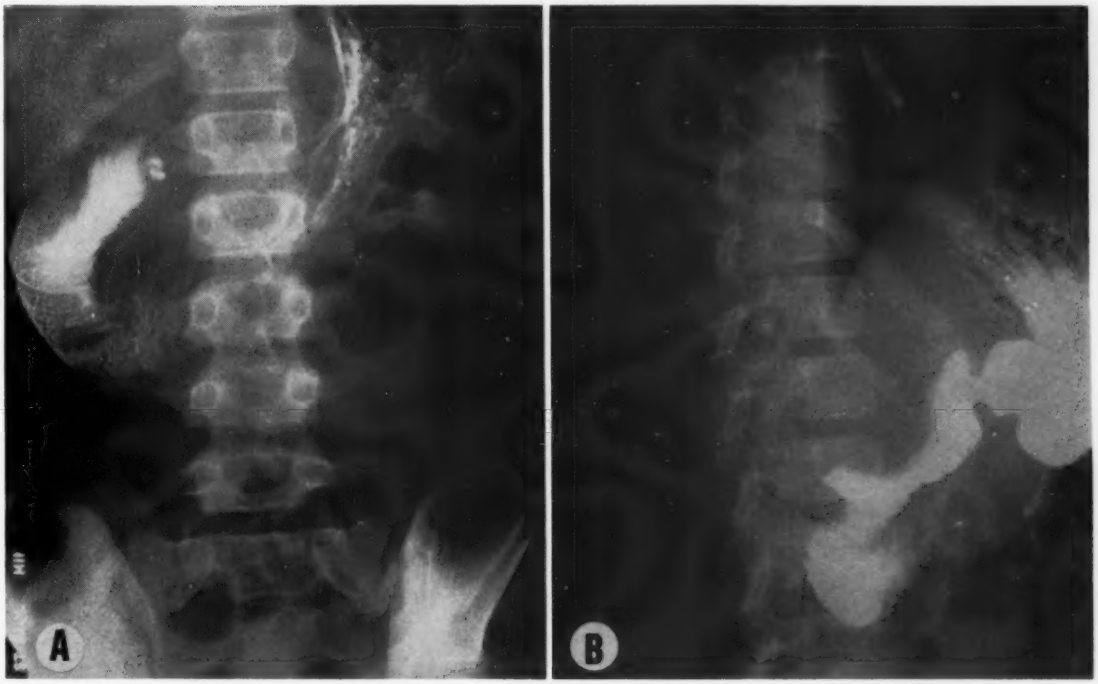


Fig. 4. Choledochal cyst. (*A* and *B*) Characteristic indentation on posterolateral aspect of descending portion of duodenum.

ing colon and the duodenojejunal junction anteriorly, but these almost never occur with an enlarged spleen.

OTHER INTRAPERITONEAL MASSES

Intrinsic lesions of the alimentary canal are usually diagnosed with the aid of appropriate contrast studies. Extra-alimentary masses of intraperitoneal origin displace or impinge upon various intestinal loops. The kidneys and ureters are not significantly displaced unless the mass is quite large, and complete ureteral obstruction is rare. In lateral views the anterior relationship of the mass is apparent.

Mesenteric and omental cysts are derived from lymphatic channels and are separate from the intestinal wall. They differ chiefly in anatomic location. The mesenteric cyst (Fig. 5) is seen in the course of the mesocolon or the root of the mesentery,[17] and, at times, two apparent masses forming a dumbbell shape may occur.[33] This cyst may calcify and rarely there may be multiple mesenteric cysts.[14] In the lateral view the omental cyst is seen just posterior to the anterior abdominal wall.

A cyst of the middle portion of the omphalomesenteric or vitelline duct[33] results in the formation of a subumbilical cystic mass. Persistence of the proximal portion of the vitelline duct results in the formation of Meckel's diverticulum in the distal ileum. Occasionally the latter anomaly is visualized as a pocket containing gas[20] or barium.

The enterogenous cyst, or alimentary duplication, usually has one portion of its wall in continuity with the intestinal wall, although it is unusual for the interior of the cyst to communicate with the lumen of the bowel.[14,33] This factor of mural continuity may cause the cyst to encroach upon the intestinal wall, leading to partial intestinal obstruction, or may cause interference with the common blood supply with production of necrosis and hemorrhage. Barium studies may demonstrate that the mass is adjacent to an area of partial obstruction. The barium study is not always necessary (Fig. 6).

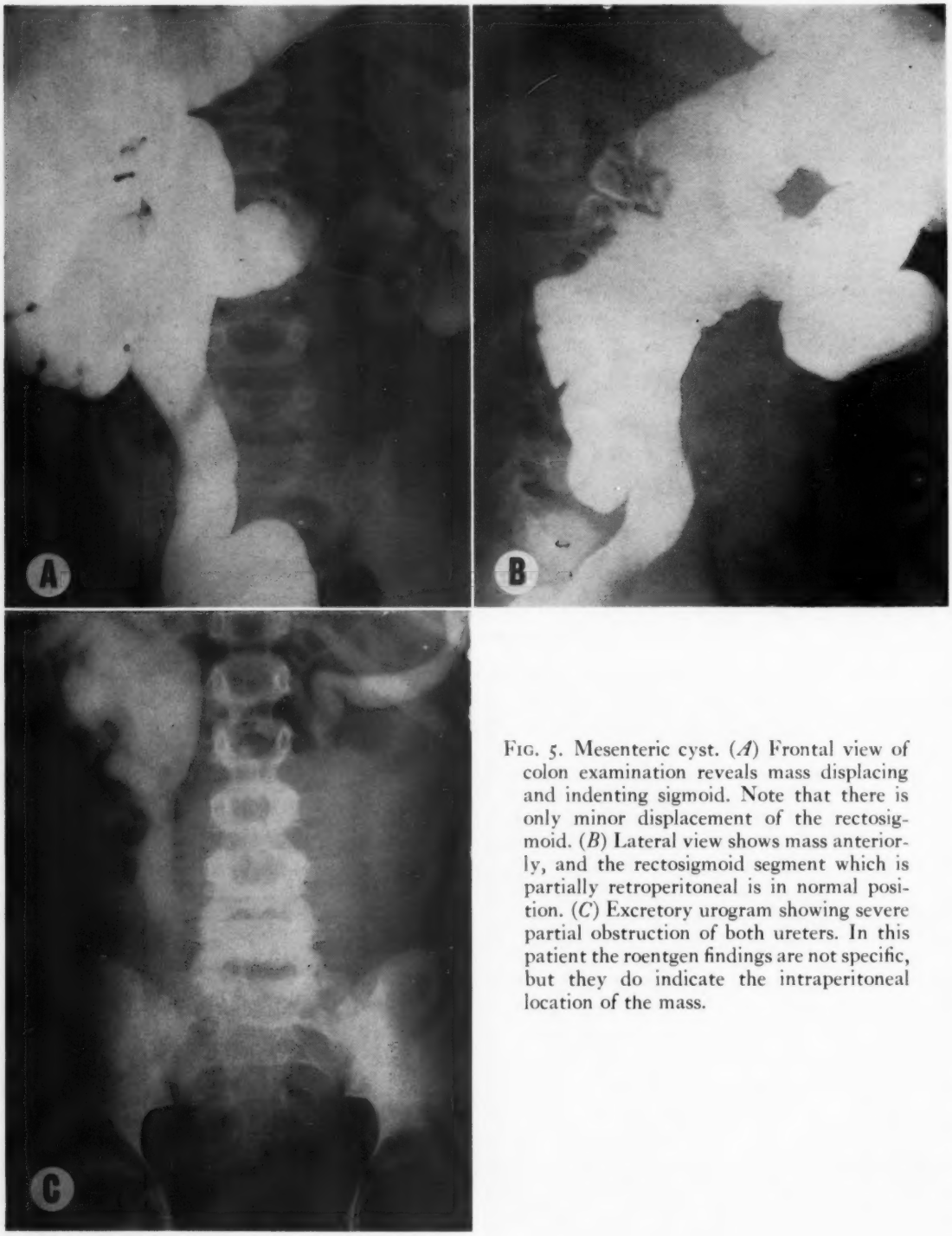


FIG. 5. Mesenteric cyst. (*A*) Frontal view of colon examination reveals mass displacing and indenting sigmoid. Note that there is only minor displacement of the rectosigmoid. (*B*) Lateral view shows mass anteriorly, and the rectosigmoid segment which is partially retroperitoneal is in normal position. (*C*) Excretory urogram showing severe partial obstruction of both ureters. In this patient the roentgen findings are not specific, but they do indicate the intraperitoneal location of the mass.

An appendiceal abscess is seen as a rather poorly defined opaque area in the right lower abdominal quadrant. Small bubbles of gas may be seen within the abscess, and an indentation of the contiguous intestine may be present. Signs of local or generalized peritoneal irritation, or of partial intestinal obstruction also

occur. Abscesses may occur in other intraperitoneal and extraperitoneal locations in the abdomen and pelvis. Usually these may be suspected by analyzing the local signs of abscess and displacement of neighboring structures.

Intussusception is identified as a mass protruding into the intestinal lumen, usually in the ileum, ascending or proximal transverse colon, with obstruction proximal to the mass. Contrast enema demonstrates the so-called "coiled spring" effect produced by the entrance of the contrast substance into the narrow space between the intussusceptum and intussuscipiens.

Teratomas and dermoid cysts of the ovary occur in the pelvis, in most cases slightly to one side of the midline, and very frequently show characteristic calcification, dental structures or radiolucent layering in the upright position[19] which is attributed to the presence of fatty or sebaceous material (Fig. 7).

Lymphangioma of the intestine and mesentery is a rare condition which may follow an extensive course through the mesentery and associated intestine. The intestinal loops are separated and their walls thickened. This process may simulate ascites, from which it is differentiated by positioning, the presence of narrowed intestinal lumen, and by the presence of lymphangiomas elsewhere in the patient (Fig. 8).

Fig. 6. Duplication cyst of small bowel. This case illustrates how careful analysis of a single film may reveal a sharply outlined mass separate from liver and kidney, displacing intraperitoneal structures only, and producing partial intestinal obstruction; these findings usually indicate an alimentary duplication cyst.

MASSES OF THE RENAL AND ADRENAL REGION

These retroperitoneal tumefactions displace the intraperitoneal structures, such as small intestinal loops, in an anterior direction and to either side. In addition, they may also displace retroperitoneal structures in any direction. Some form of retroperitoneal growth is necessary to displace anteriorly the duodenojejunal junction,[4,8] ascending colon and descending colon, or to cause complete ureteral obstruction.

Wilms' tumor is the most common tumor of the abdomen in childhood.[14] On plain roentgenograms a mass is seen arising in either renal area, displacing intestinal loops anteriorly and to either side. Calcification of nonspecific character may be noted. Urographic studies reveal that the calyces are distorted and may be invaded by tumor tissue. The renal pelvis may be relatively normal, or may be compressed or elongated. Further, the renal pelvis may appear to "ride" at the upper or lower pole of the tumor, and may be displaced medially, anteriorly or posteriorly. Nonvisualization is rare. The upper portion of the ureter may be displaced medially (Fig. 9, 10, 11). Renal carcinoma is indistinguishable by this method from Wilms' tumor but is very rare in infancy and childhood.

A renal cyst is seen as a smooth round mass which may displace but never in-

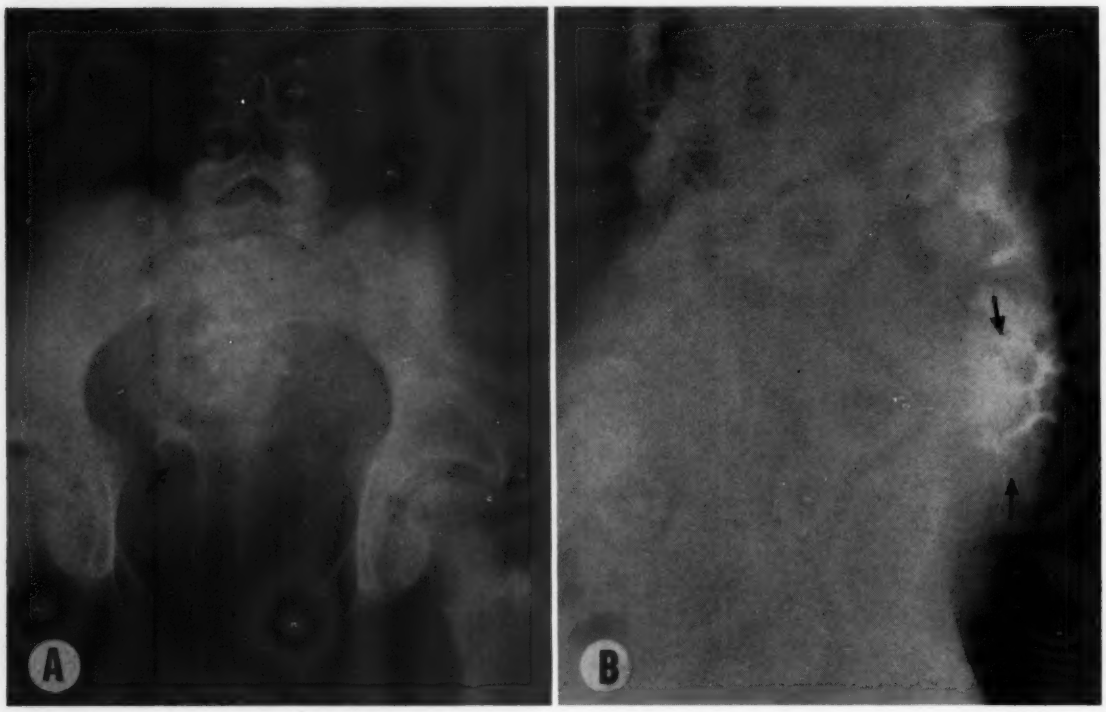


FIG. 7. Ovarian teratoma. (*A*) Pelvic mass with calcification suggesting cystic structure (arrow). (*B*) Lateral view indicates mass is intraperitoneal (arrows). These findings are characteristic, and almost specific.

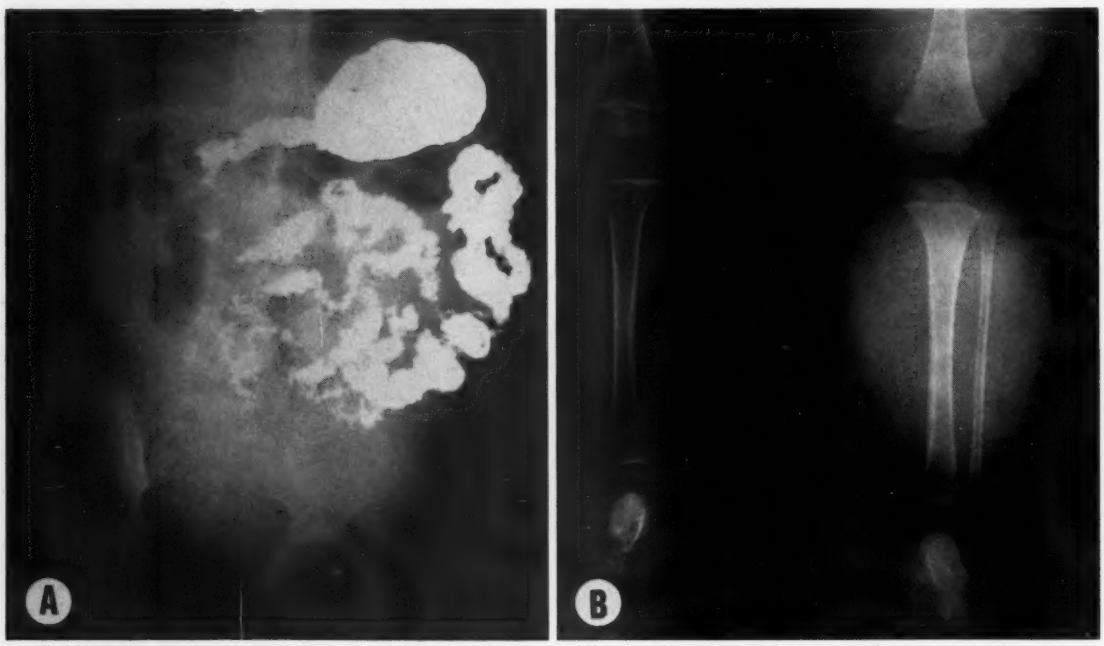


FIG. 8. Lymphangioma of mesentery, small intestine and abdominal wall. (*A*) Oral barium study reveals separated loops of small intestine which have thickened wall and narrowed lumen. (*B*) Lymphangioma of left thigh and leg.

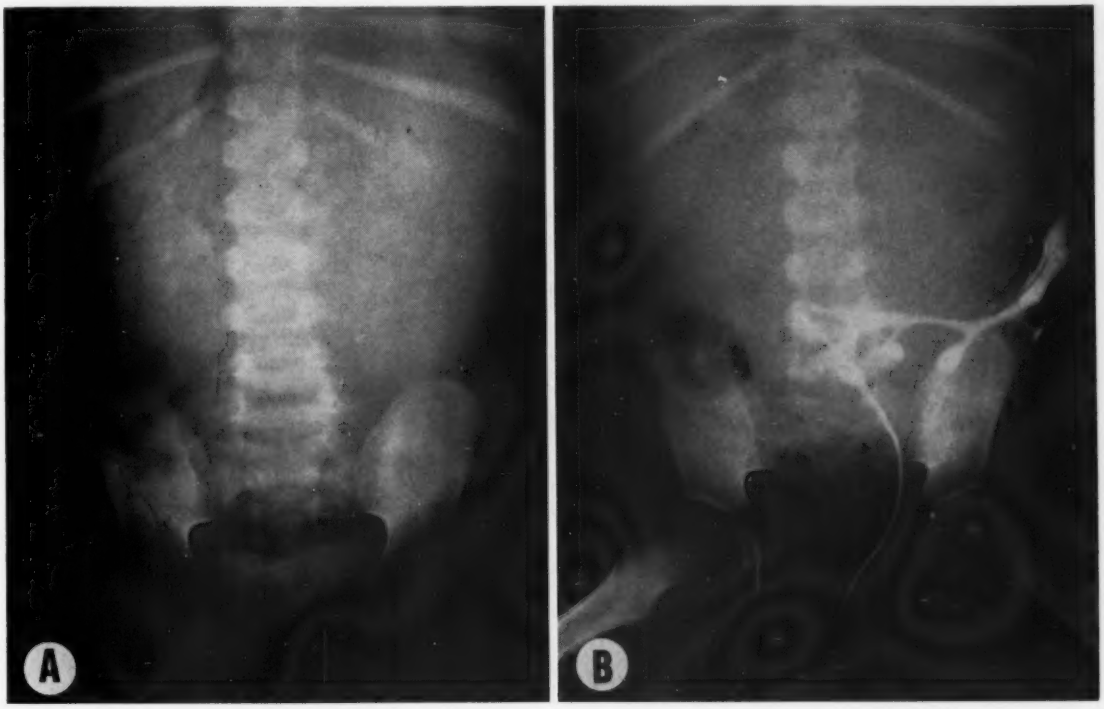


Fig. 9. Wilms' tumor of left kidney. (*A*) Excretory urogram shows large mass inseparable from kidney, which is nonfunctioning (unusual). (*B*) Left retrograde pyelogram reveals extreme distortion of renal pelvis and calyces.

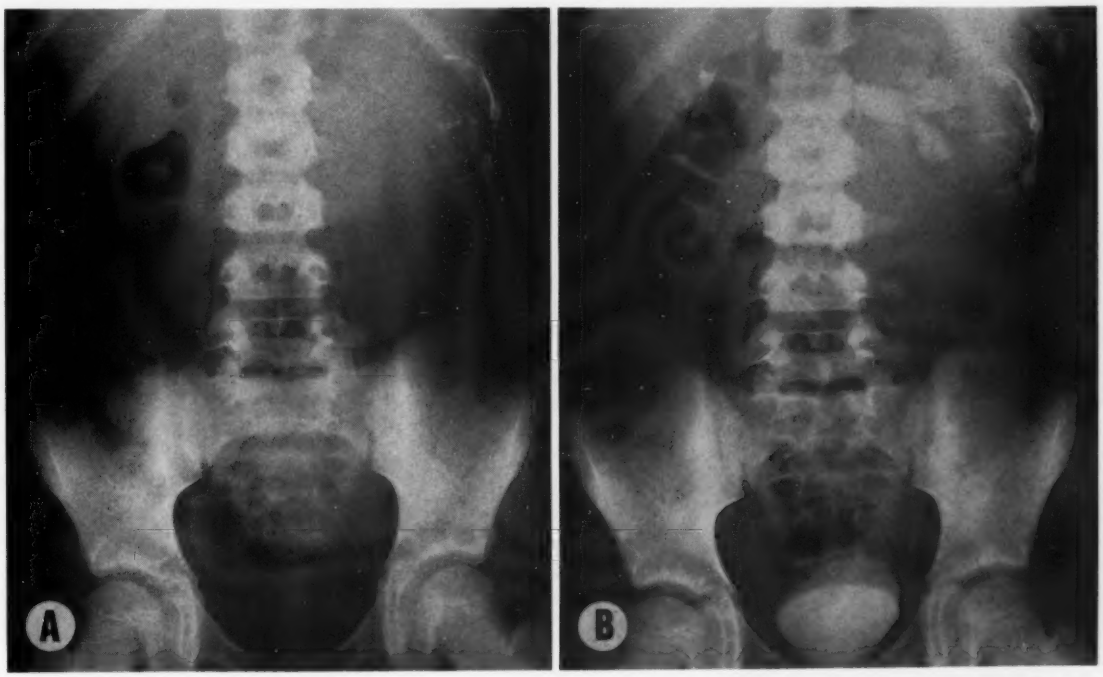


Fig. 10. Wilms' tumor of left kidney. (*A*) Calcification in large mass. (*B*) Excretory urogram confirms that calcification is within left kidney. Medial displacement of renal pelvis with hydronephrosis.

vades the calyces (Fig. 12). Polycystic kidneys produce bilateral enlargement with rounded indentations in the calyces on the urogram. Usually these patients die early in infancy, or the condition does not become clinically apparent until adult life. Bilateral renal enlargement with somewhat similar distortion of the calyces suggests leukemic infiltration.[13]

Neuroblastoma sympathicum is probably the second most common abdominal tumor in infants.[14] It arises from the adrenal medulla (Fig. 13, 14) or from extra-adrenal portions of the chromaffin system (Fig. 15), and is highly malignant. Calcification is rather common.[24] We have seen one patient with extensive calcification both in the primary tumor and in metastases (Fig. 21). The neuroblastoma grows rapidly and

FIG. 11. Wilms' tumor of right kidney. Excretory urogram shows extreme distortion of upper pole; the diffuse nature of the calyceal involvement tends to differentiate this from adrenal neuroblastoma.

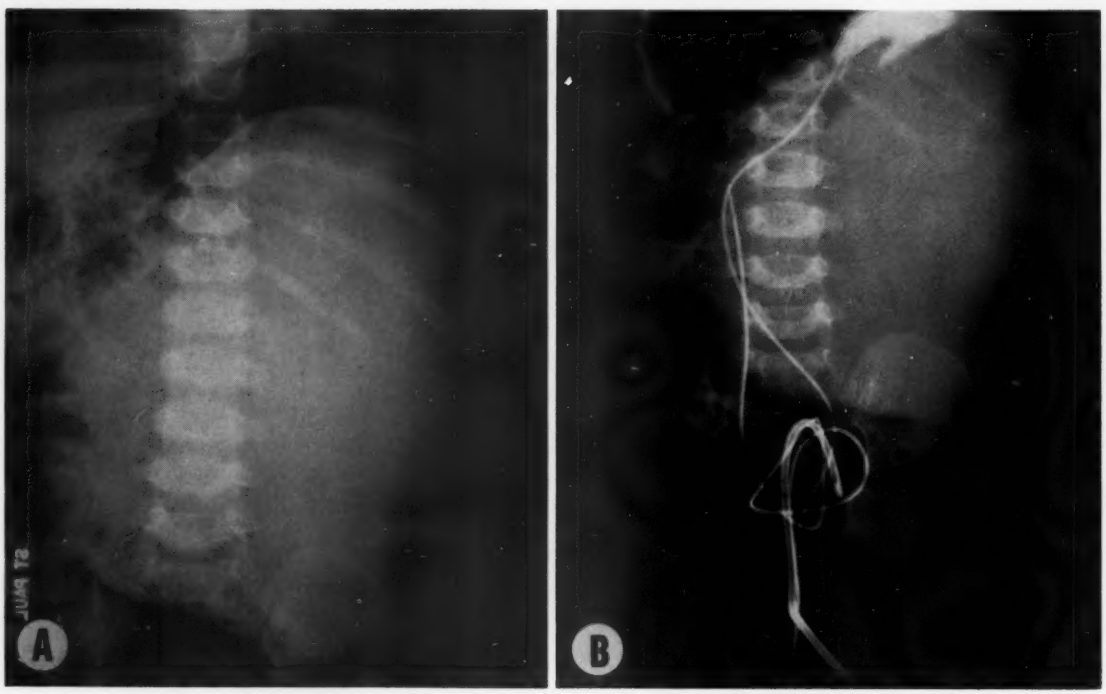


FIG. 12. Solitary renal cyst. (*A*) Large sharply outlined mass predominantly in left abdomen. Left renal outline not visible. (*B*) Left retrograde urogram shows upward displacement of renal pelvis by a rounded mass within the kidney.

is highly invasive. Arising on either side of the vertebral column, it may extend to the other side or even invade the vertebral bodies or pedicles.[14] Plain roentgenograms show anterior and centrifugal displacement of intestinal loops. The tumor may extend behind the duodenojejunal junction as well as other retroperitoneal structures. In contrast urography the kidney is displaced downward and sometimes laterally. This tumor metastasizes widely to the liver, skeleton, skull, brain and lungs, a distribution which differs from that of Wilms' tumor. Skeletal metastases may simulate leukemic infiltration; any spicule formation favors the diagnosis of neuroblastoma, whereas involvement of the distal third of the extremities favors leukemia.[14]

Other adrenal medullary tumors include the benign ganglioneuroma and the pheochromocytoma, both much less common than neuroblastoma in children. The latter tumor secretes an epinephrine-like substance which gives rise to an intermittent or continuous hypertension.

Fig. 13. Neuroblastoma of left adrenal. Retrograde urogram shows mass with calcification (arrow) producing downward and lateral displacement of the left kidney. The mass extends across the midline and rotates the right kidney, and also displaces the ureteropelvic juncture, producing hydronephrosis.

Fig. 14. Neuroblastoma of left adrenal. Retrograde urogram reveals downward and lateral displacement of the left kidney without intrinsic deformity of the renal pelvis or calyces.

Adrenal cortical tumors, adenoma and carcinoma give rise to masculinization and advanced skeletal development (Fig. 16).

With the above discussion firmly in mind it is possible, in the majority of patients, to distinguish renal and adrenal masses, and often to make a specific diagnosis.

OTHER EXTRAPERITONEAL MASSES

Retroperitoneal teratoma is the third most common retroperitoneal tumor of childhood.[1,16,23] This tumor occurs most frequently in the sacrococcygeal area and next most frequently in the paravertebral gutter.[23] Those of the latter group generally arise rather high in the abdomen, close to

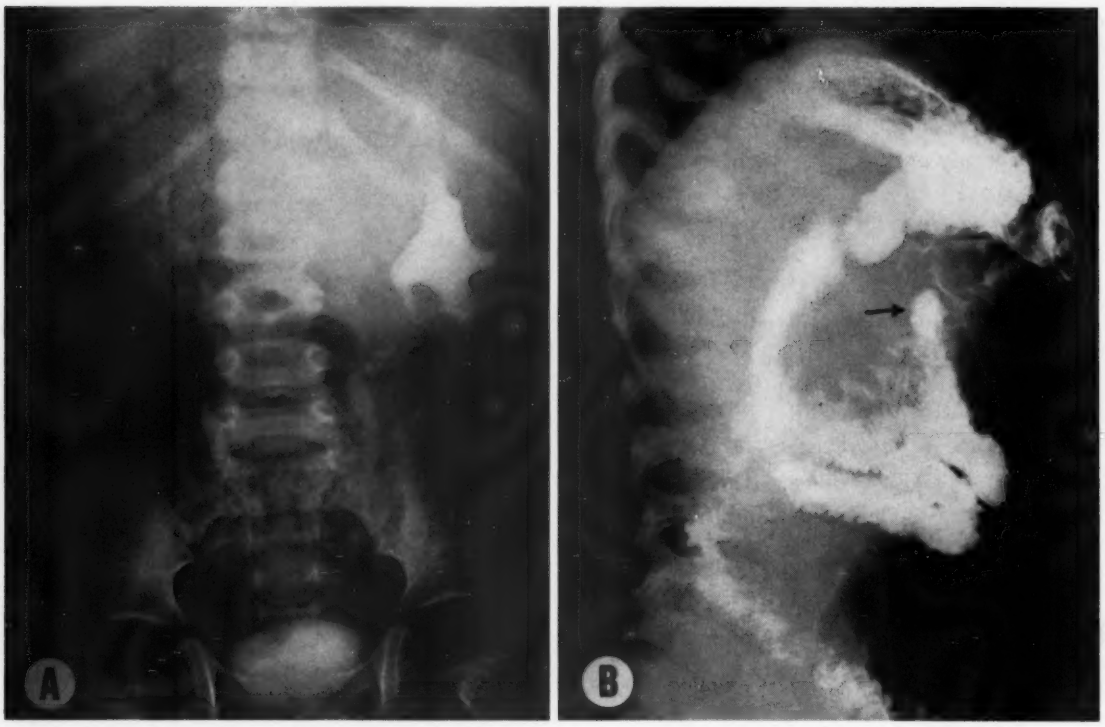


FIG. 15. Neuroblastoma arising in extra-adrenal chromaffin tissue. (*A*) Retroperitoneal mass displacing left kidney and upper ureter to left. (*B*) Lateral view after barium meal reveals anterior dislocation of duodenojejunal (arrow) as well as of intraperitoneal alimentary structures. Differential diagnosis would include pancreatic tumor and retroperitoneal lymphoma.

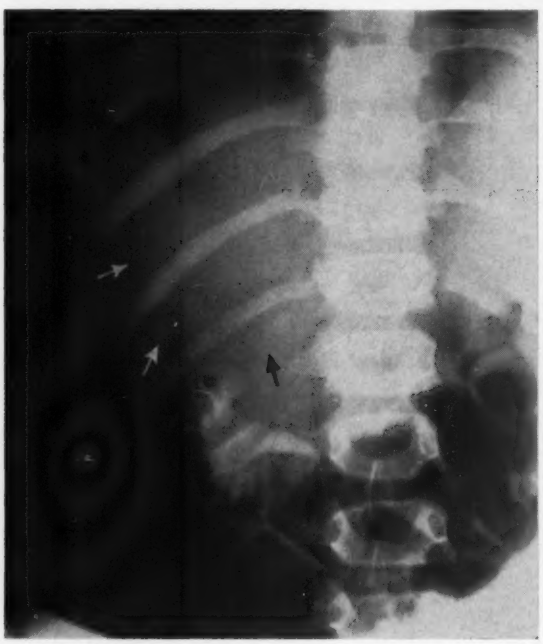


FIG. 16. Carcinoma of adrenal cortex. Ill-defined mass causing downward displacement of right kidney (arrows). This three year old child had skeletal development of a nine year old.

FIG. 17. Retroperitoneal teratoma (included twin). The pronounced displacement of both the ascending and descending colon indicates retroperitoneal location.

the pancreas and kidneys. They may lie entirely to one side of the midline, but many bulge beyond the spinal column. The tumor is particularly apt to be detected in the first months of life, more than one-half being seen in the first year, and about two-thirds being seen in the first two years. Roentgenographically, a mass is seen displacing the small intestinal loops anteriorly and centrifugally. A very high proportion show some irregular calcification, which may be spotty or simulate mature osseous formation. An extreme degree of differentiation[27] is known as included twin or *fetus in fetu* (Fig. 17). Urography reveals displacement of the ipsilateral kidney and hydronephrosis may be caused by pressure on a ureter. Extensive distortion and invasion of the renal pelvis and calyces does not occur, thus differing from Wilms' tumor. Rarely, retroperitoneal pneumography may be required to show that the teratoma is unattached to other structures.

Pancreatic cysts, pseudocysts and the relatively rare cystadenocarcinoma of the pancreas give rise to a variety of topographic configurations. Several authors[9,30,33] list and illustrate the following:

1. Cyst of head of pancreas enlarging the duodenal loop.
2. Gastrohepatic type, enlarging between the lesser curvature of the stomach and the liver.
3. Gastrocolic type, enlarging between the stomach and transverse colon.
4. Gastrosplenic type, enlarging between the stomach and splenic flexure.
5. Gastrocolic type, enlarging between the stomach and distal transverse colon.
6. Mesocolic type, enlarging into the mesocolon and below the transverse colon.

The most common is the gastrocolic type which enlarges between the stomach and

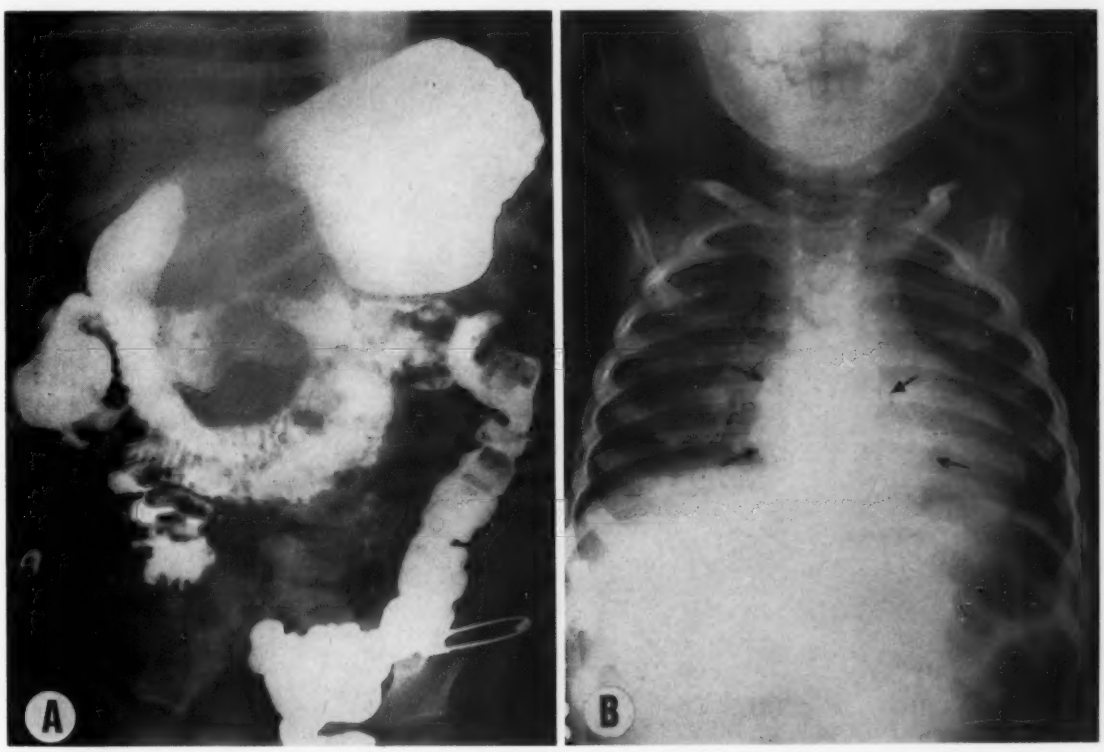


Fig. 18. Retroperitoneal lymphoma. (*A*) Enlargement of duodenal loop and separation of stomach from colon, similar to pancreatic mass. (*B*) Involvement of mediastinal lymph nodes (arrows) tends to confirm the diagnosis of lymphoma.

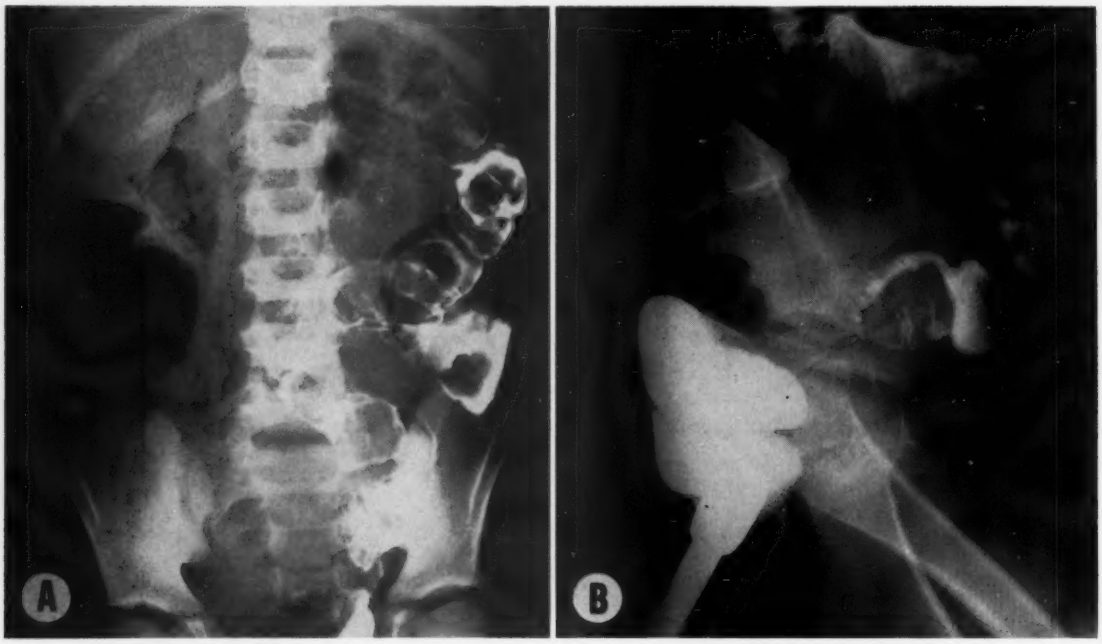


FIG. 19. Retroperitoneal fibrosarcoma arising in pelvic region. (*A*) Barium enema study reveals displacement of rectosigmoid junction to left. (*B*) Lateral view shows anterior displacement of rectosigmoid junction, indicating retroperitoneal location of mass. Compare with Figure 5.

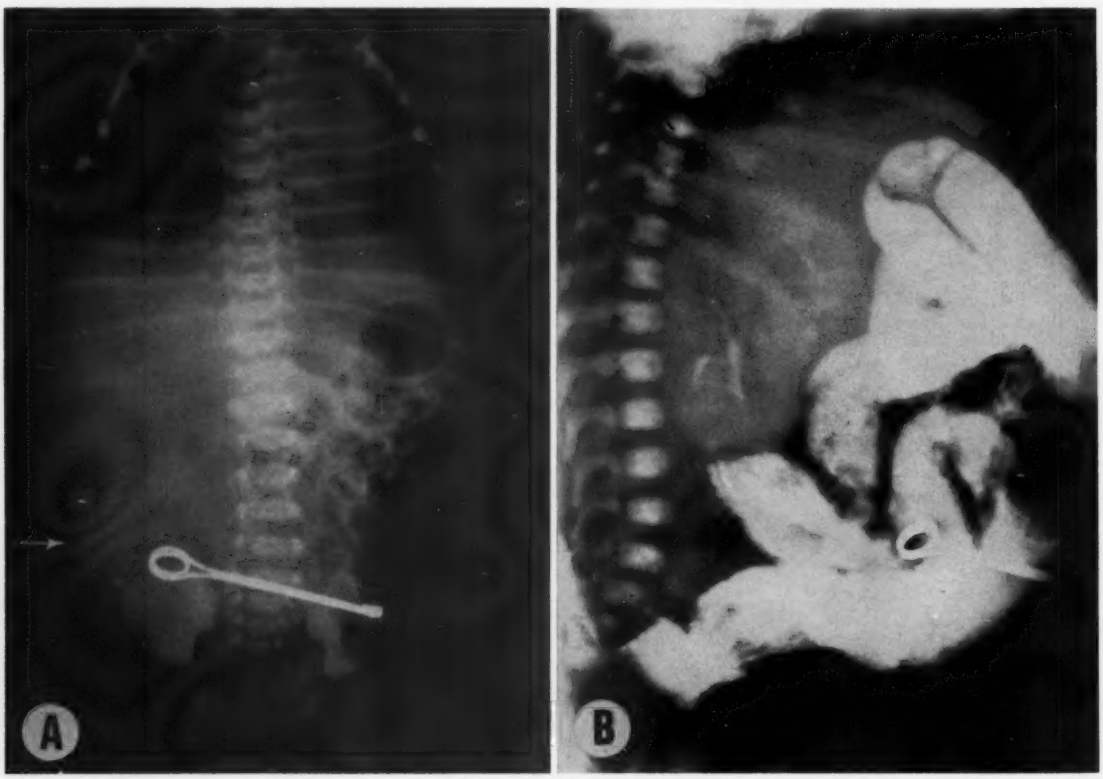


FIG. 20. Retroperitoneal cavernous hemangioma. (*A*) Mass in right side of abdomen with non-characteristic calcification (arrow). (*B*) Mass is retroperitoneal, displacing ascending colon forward. Kidneys are functioning well in normal position and are separate from the mass. (Reproduced from *Minnesota Medicine* by permission.)

the midportion of the transverse colon. In common with other tumors and abscesses in contact with the lesser omentum and the left upper abdominal quadrant, pancreatic cysts may be associated with elevation of the left hemidiaphragm and basilar atelectasis of the left lung.

Lymphomas, including lymphatic leukemia, may invade the retroperitoneal lymph nodes, and may simulate pancreatic masses in enlarging the duodenal loop or separating the stomach and transverse colon. The presence of nodular masses beyond this region, particularly in the mediastinum, aids in roentgen differentiation (Fig. 17).

The urachal cyst[33] is an extraperitoneal mass which occurs in the midline anteriorly in the suprapubic area, and which indents the anterosuperior portion of the fundus of the bladder.

Hydrometrocolpos is a cystic dilatation of the vagina and uterus in infants. It is associated with imperforate hymen or vaginal atresia, combined with copious secretions of the uterine glands. In hematocolpos, the imperforate hymen, present from birth, does not result in dilatation of the vagina until the onset of puberty. In hydrometrocolpos the cystic structure is seen rising from the midsagittal and midcoronal planes of the pelvis. It displaces and may obstruct intestinal or urinary structures. It may extend superiorly to the extent of limiting diaphragmatic excursion. A notch in the roentgenographic opacity may indicate the partial separation of vaginal and uterine distention. If further confirmation is needed, contrast material may be injected into the cyst through the imperforate hymen.[33]

Fibrosarcoma and rhabdomyosarcoma are rare extraperitoneal tumors which may attain a large size. The roentgen findings are not specific (Fig. 18). Rhabdomyosarcoma is a very malignant neoplasm. It frequently presents metastases at the time of or before discovery of the primary lesion.

Extraperitoneal hemangioma[2] may be suspected if an extraperitoneal mass shows calcification simulating phleboliths or if a known hemangioma is present elsewhere in the patient (Fig. 19).

Fig. 21. Retroperitoneal metastases with calcification. Extensive lymph nodal mass with calcification is rare but when it occurs it is suggestive of neuroblastoma. The primary tumor in this patient is seen as a calcified mass in the region of the right adrenal.

Meningoceles may protrude internally into the thorax, abdomen or pelvis.[18,25,28,31] A retroperitoneal mass associated with a defect in the lumbar or sacral portion of the spine is characteristic. Pneumomyelography[33] may be used to confirm the diagnosis. Sherman, *et al.*[31] stress the high incidence of meningitis following surgery in these patients and believe that surgery is contraindicated unless performed in a strictly aseptic manner.

DISCUSSION

It is obvious that a specific diagnosis of all conditions producing abdominal masses in infants and children cannot be made from the roentgen findings alone. As shown in some of the illustrations, it is often possible only to indicate the size and rela-

tive location of the mass, and to determine whether it is intraperitoneal or extraperitoneal. However, it is surprising how much information may be obtained from careful analysis of commonly used roentgenographic procedures. The more complicated procedures, such as pneumoperitoneum, retropneumoperitoneum and other special contrast injection techniques are rarely needed. The use of the lateral view should not be neglected, for it often provides useful information. Correlation with roentgen studies of other portions of the body, or with other laboratory and clinical data, is also stressed.

We have not attempted to present the diagnostic findings in all abdominal masses of childhood. There are some conditions, such as the characteristically calcified hydatid cyst,[22,27] which are rare in this country. This presentation is rather a description of an approach to the diagnosis of abdominal masses in infants and children.

SUMMARY AND CONCLUSIONS

Many abdominal masses in infants and children may be diagnosed with relative degrees of specificity by conventional roentgen methods.

The diagnosis is based on careful topographic analysis, general roentgen characteristics and various relatively specific signs considered in the light of statistical probability.

The use of the lateral view in simple roentgenography and in contrast studies is emphasized.

Roentgen studies of other regions and correlation with other pertinent laboratory and clinical data result in a still higher percentage of more specific diagnoses.

Charles M. Nice, Jr.
Department of Radiology
University of Minnesota
Medical School
Minneapolis 14, Minnesota

REFERENCES

1. ARNHEIM, E. E. Retroperitoneal teratomas in infancy and childhood. *Pediatrics*, 1951, *8*, 309–327.
2. AURELIUS, J. R., PETERSON, D. H., and NIKNEJAD, I. Retroperitoneal cavernous hemangioma associated with hemangiomas of skin in newborn. *Minnesota Med.*, 1955, *38*, 32–37.
3. BROWN, S. Differential diagnosis of abdominal tumors by roentgenological method. *Radiology*, 1928, *10*, 48–56.
4. BROWN, S. Radiological study of stomach and duodenum, with special reference to value of lateral view. *Radiology*, 1931, *17*, 85–98.
5. BROWN, S., and FINE, A. Surgical anatomy of abdomen; roentgenologic study. *Radiology*, 1937, *28*, 73–84.
6. BUTLER, P. F., and RITVO, M. Extra-bowel pathology. AM. J. ROENTGENOL. & RAD. THERAPY, 1931, *25*, 474–481.
7. CAFFEY, J. Pediatric X-Ray Diagnosis. Second edition. Year Book Publishers, Inc., Chicago, 1950.
8. CAPURRO, F. G., and BLANCO, R. P. Semiologia Clinico-Radiologica de las Tumoraciones Abdominales. A. Monteverde & Cia, Montevideo, Uruguay, 1946.
9. CASE, J. T. Roentgenology of pancreatic disease. AM. J. ROENTGENOL. & RAD. THERAPY, 1940, *44*, 485–518.
10. DICKSON, W. H. Diagnosis of obscure abdominal lesions by roentgen gastrointestinal examinations. AM. J. ROENTGENOL. & RAD. THERAPY, 1923, *10*, 540–546.
11. DONNELLY, B. A. Primary retroperitoneal tumors; report of 95 cases and review of literature. *Surg., Gynec. & Obst.*, 1946, *83*, 705–717.
12. FISHBACK, H. R., JR. Renal dystopia due to intra-abdominal masses. AM. J. ROENTGENOL. & RAD. THERAPY, 1944, *52*, 521–528.
13. GOWDY, J. F., and NEUHAUSER, E. B. D. Roentgen diagnosis of diffuse leukemic infiltration of kidneys in children. AM. J. ROENTGENOL. & RAD. THERAPY, 1948, *60*, 13–21.
14. GROSS, R. E. The Surgery of Infancy and Childhood. W. B. Saunders Company, Philadelphia, 1953.
15. GUARDABASSI, L. Contributo della indagine pielografica alla diagnosi di tumori abdominali extrarenali. *Radiol. med.*, 1940, *27*, 224–237.
16. HANSMANN, G. H., and BUDD, J. W. Massive unattached retroperitoneal tumors; explanation of unattached retroperitoneal tumors based on remnants of embryonic urogenital appartus. *J.A.M.A.*, 1932, *98*, 6–10.
17. HINKEL, C. L. Mesenteric cysts: Their roentgen diagnosis. AM. J. ROENTGENOL. & RAD. THERAPY, 1942, *48*, 167–176.
18. KESSEL, A. W. L. Intrathoracic meningocele, spinal deformity, and multiple neurofibromatosis. *J. Bone & Joint Surg.*, 1951, *33-B*, 87–93.
19. LAURELL, H. Other contributions to roentgen-

ology of mixed tumors. *Acta radiol.*, 1925, *4*, 480–498.

20. LERNER, H. H., LEVINSON, S. S., and KATEMAN, A. E. Meckel's diverticulum; new roentgen diagnostic sign and case report. AM. J. ROENTGENOL. & RAD. THERAPY, 1953, *69*, 268–271.
21. MARGULIS, A. R., NICE, C. M., JR., and RIGLER, L. G. Roentgen findings in primary hepatoma in infants and children; analysis of eleven cases. *Radiology*, To be published.
22. MCCULLOUGH, J. A. L., and SUTHERLAND, C. G. Intra-abdominal calcification: Interpretation of its roentgenologic manifestations. *Radiology*, 1941, *36*, 450–457.
23. PALUMBO, L. T., CROSS, K. R., SMITH, A. N., and BARONAS, A. A. Primary teratomas of lateral retroperitoneal spaces. *Surgery*, 1949, *26*, 149–159.
24. PARSONS, P. B., and PLATT, L. Calcification in abdominal neuroblastoma. AM. J. ROENTGENOL. & RAD. THERAPY, 1940, *44*, 175–177.
25. PENDERGRASS, R. C., WALKER, A. E., and BOND, J. P. Extraspinal lumbar meningocele. *J. Neurosurg.*, 1947, *4*, 80–86.
26. RIGLER, L. G. Diagnosis of extra-gastro-intestinal abdominal masses. *Radiology*, 1933, *21*, 229–238.
27. ROSE, C. B. Diagnosis of unusual calcareous shadows found on x-ray films of abdomen. *Radiology*, 1939, *32*, 600–608.
28. SENGPIEL, G. W., RUZICKA, F. F., and LODMELL, E. A. Lateral intrathoracic meningocele. *Radiology*, 1948, *50*, 515–519.
29. SHAMBAUGH, P. Displacements of left kidney in diagnosis of tumors of left flank and abdomen. *Radiology*, 1936, *26*, 335–339.
30. SHANKS, S. C., and KERLEY, P. A Text-Book of X-Ray Diagnosis by British Authors. Vol. III, Abdomen. W. B. Saunders Company, Philadelphia, 1950.
31. SHERMAN, R. M., CAYLOR, H. D., and LONG, L. Anterior sacral meningocele. *Am. J. Surg.*, 1950, *79*, 743–747.
32. WIESE, H. W., and LARIMORE, J. W. Roentgenology of extra-alimentary tumors. AM. J. ROENTGENOL. & RAD. THERAPY, 1932, *27*, 383–404.
33. WILSON, J. W. Diagnosis of abdominal cysts in infants and children. *Radiology*, 1955, *64*, 178–190.

THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

Editor: Lawrence Reynolds, M.D.

Associate Editors: Harry Hauser, M.D., Traian Leucutia, M.D., Russell H. Morgan, M.D., Edward B. D. Neuhauser, M.D., Wendell G. Scott, M.D.

Consulting Editorial Board: See front cover.

Published by: Charles C Thomas, Publisher, 301–327 East Lawrence Avenue, Springfield, Illinois.

Issued monthly. Annual subscription: United States, Mexico, Cuba, Central and South America, $15.00; Canada, $16.00; other countries, $17.00. Current single numbers, $1.50. Advertising rates submitted on application. Editorial office, 110 Professional Building, Detroit 1, Michigan. Office of publication, 301–327 East Lawrence Avenue, Springfield, Illinois. Information of interest to authors and readers will be found on page vi.

Officers and Standing Committees

AMERICAN ROENTGEN RAY SOCIETY

President: Paul C. Hodges, Chicago, Ill.; *President-Elect:* W. Edward Chamberlain, Philadelphia, Pa.; *1st Vice-President:* Milo T. Harris, Spokane, Wash.; *2nd Vice-President:* John P. Medelman, White Bear Lake, Minn.; *Secretary:* Barton R. Young, Germantown Hospital, Philadelphia 44, Pa.; *Treasurer:* Wendell G. Scott, 35 North Central Avenue, Clayton 5, Mo.

Executive Council: P. C. Hodges, W. E. Chamberlain, M. T. Harris, B. R. Young, W. G. Scott, Lawrence Reynolds, R. K. Arbuckle, R. H. Morgan, W. A. Evans, Jr., J. C. Dickinson, H. M. Weber, J. C. Cook, C. A. Good, A. E. Childe, Wilbur Bailey, E. B. D. Neuhauser, H. O. Peterson, Chairman, 1955 W. County Road B, St. Paul 8, Minn.

Program Committee: B. R. Young, Philadelphia, Pa., R. H. Morgan, Baltimore, Md., Lawrence Reynolds, Detroit, Mich., W. A. Evans, Jr., Detroit, Mich., H. O. Peterson, St. Paul, Minn., H. M. Weber, Rochester, Minn., W. Edward Chamberlain, Chairman, Philadelphia, Pa.

Publication Committee: V. P. Collins, Houston, Texas, J. F. Roach, Albany, N. Y., H. M. Stauffer, Philadelphia, Pa., H. B. Elkins, Iowa City, Iowa, R. H. Morgan, Chairman, Baltimore, Md.

Finance and Budget Committee: E. B. D. Neuhauser, Boston, Mass., Wilbur Bailey, Los Angeles, Calif., E. L. Jenkinson, Chicago, Ill., J. L. Olpp, Englewood, N. J., R. K. Arbuckle, Chairman, Oakland, Calif.

Committee on Scientific Exhibits: Cesare Gianturco, Urbana, Ill., J. F. Holt, Ann Arbor, Mich., W. A. Evans, Jr., Chairman, Detroit, Mich.

Representatives on American Board of Radiology: T. Leucutia, Detroit, Mich., B. R. Kirklin, Rochester, Minn., H. Dabney Kerr, St. Michaels, Md.

Director of Instructional Courses: H. M. Weber, Mayo Clinic, Rochester, Minn., *Manager of Annual Meeting:* James C. Cook, 110 Professional Building, Detroit 1, Mich.

Editor: Lawrence Reynolds, 110 Professional Building, Detroit 1, Mich.

Fifty-seventh Annual Meeting: Statler Hotel, Los Angeles, Calif., September 25–28, 1956.

AMERICAN RADIUM SOCIETY

President: Grant H. Beckstrand, Long Beach, Calif.; *President-Elect:* Norman A. McCormick, Windsor, Ont.; *1st Vice-President:* Herbert E. Schmitz, Chicago, Ill.; *2nd Vice-President:* Manuel Riebeling, Guadalajara, Jal, Mexico; *Secretary:* Robert E. Fricke, Mayo Clinic, Rochester, Minn.; *Treasurer:* Douglas J. Roberts, 85 Jefferson St., Hartford 6, Conn.

Executive Committee: Howard B. Hunt, Chairman, Omaha, Nebr., Edith H. Quimby, New York, N. Y., John E. Wirth, Pasadena, Calif.

Program Committee: Grant H. Beckstrand, Chairman, Long Beach, Calif., Lewis Guiss, Los Angeles, Calif., Manuel Garcia, New Orleans, La., Gray H. Twombly, New York, N. Y., Norman McCormick (ex officio), Windsor, Ont.

Publication Committee: Harry Hauser, Chairman, Cleveland, Ohio, Martin Van Herik, Rochester, Minn., J. Robert Andrews, Bethesda, Md.

Public Relations Committee: Palmer E. Wigby, Chairman, Houston, Texas, John A. Wall, Houston, Texas, James A. Chamberlin, Houston, Texas.

Janeway Lecture Committee: Douglas Quick, Chairman, New York, N. Y., Gioacchino Failla, New York, N. Y., H. Dabney Kerr, St. Michaels, Md.

Representatives on the American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., Frederick W. O'Brien, Boston, Mass.

Representatives on National Committee on Radiation Protection: Edith H. Quimby, New York N. Y., Theodore P. Eberhard, Ann Arbor, Mich.

Committee on Arrangements: William S. MacComb, Chairman, Houston, Texas, John A. Wall, Houston, Texas, James A. Chamberlin, Houston, Texas, Palmer E. Wigby, Houston, Texas, R. Kenneth Loeffler, Houston, Texas, Eleanor J. MacDonald, Houston, Texas, Gilbert H. Fletcher, Houston, Texas, David M. Earl, Houston, Texas, Vincent P. Collins, Houston, Texas, Grant H. Beckstrand (ex officio), Long Beach, Calif.

Thirty-eighth Annual Meeting: Shamrock Hotel, Houston, Texas, April 9–11, 1956.

EDITORIALS

RADIOLOGY AND ITS CONTRIBUTION TO UROLOGY

UROLOGY can be said to owe its existence as a specialty to the inventive genius of Thomas Edison and Wilhelm Conrad Röntgen. The incandescent light made possible the development of the cystoscope which permitted precise examination of the urinary tract as well as endoscopic treatment of many conditions that had previously been accessible only by open surgical methods. And the roentgen ray provided a means whereby diagnostic studies of the entire urogenital tract could be carried out. The joint application of these developments established urology as a field of clinical specialization, for skills in cystoscopy were essential to the full utilization of radiology in the urogenital tract.

In 1896, only a year after the announcement of Röntgen's discovery, the researches of Chapius and Chauvel demonstrated the possibility of diagnosing urinary calculi by means of the roentgen rays; and in the London *Lancet* of July 11, 1896 T. Macintyre of Glasgow reported the first case in which roentgen rays were successfully employed for this purpose. A year later Tuffier suggested the use of radiopaque catheters but their actual use was not described until 1901 when Schmidt and Kolischer each reported their clinical employment.

The possibility of demonstrating the upper urinary tract by injecting contrast medium was discovered fortuitously by Völcker and von Lichtenberg while making roentgenograms of the bladder using colloidal silver (collargol). One of their plates demonstrated that the solution had entered the ureter and renal pelvis and outlined these in the roentgenogram. Later deliberate attempts were made to fill the renal pelvis by means of ureteral catheters which resulted in successful pyelograms. They reported their results in 1906, and called attention to the value of "pyelography" (which they named) as an aid to diagnosis. Many chemicals were used for contrast media in retrograde pyelography. Lime water was tried—but gave no shadow. Bismuth preparations were used and abandoned; the soluble salts were found to be toxic and the insoluble salts too difficult to inject. Collargol and argyrol were widely employed but were difficult to handle, dirty to use, and quite expensive. Silver iodide, thorium nitrate-citrate, and silver nitrate were all tried and abandoned, as was sodium bromide. Finally Cameron asserted the advantages of sodium iodide in 15 per cent solution and this material was widely employed for many years.

William Braasch of the Mayo Clinic was a pioneer in the clinical use of pyelography and his writings were pre-eminent in furthering this new science.

The advantages of excretory urography were early recognized and efforts were made to find radiopaque substances that could safely be injected intravenously and would be subsequently excreted by the kidneys. Rowntree and his associates at the Mayo Clinic reported in 1923 that faint shadows of the kidneys and bladder could sometimes be seen on roentgenographic plates after intravenous administration of 200 cc. of 15 per cent sodium iodide. However, many patients were intolerant of this amount of the substance so its clinical use was not practical. The report of Rowntree may have suggested the employment of sodium iodide for arteriography for within a year Barney Brooks reported its use in the study of vascular diseases of the extremities.

Excretory pyelography became a practi-

cal reality in 1929, when von Lichtenberg and Swick reported the successful use of uroselectan. The development of this compound comprises an interesting story for it was created by Professor Arthur Binz. Binz succeeded to Dr. Paul Ehrlich's chair and inherited all his notebooks of experimental data. He carried on further studies with the benzol ring in the hope of improving upon salvarsan, and failing, tried the pyridine ring. He and his co-worker, Räth, combined iodine with the pyridine ring and this compound, which they called "selectan-neutral" was tried experimentally as an antiseptic for the intravenous treatment of infections. It was not effective as an antibacterial agent but they found that the compound was partially excreted in the urine and might be utilized in outlining the urinary tract. This discovery led the way to the deliberate creation of other compounds with greater iodine content which had low toxicity. Thus Ehrlich's successor, instead of originating a new antisyphilitic drug, accidentally became the father of excretory pyelography. Other materials have followed uroselectan and only recently a new and different compound was synthesized by Dr. V. H. Wallingford in this country which has led to the creation of urokon, hypaque and miokon, all of which are greatly superior to any of their forerunners.

Another roentgenographic technique that has contributed importantly to urologic diagnosis is retroperitoneal pneumography, which was introduced in 1921 by Carelli and Rosenstein. The procedure was not widely accepted at the time but its merit was emphasized in 1929, when Langeron reported that air introduced intraperitoneally had outlined a large adrenal tumor on a roentgenogram. Dr. George Cahill in 1935 made the first report on the use of perirenal air insufflation to determine the presence of a suspected adrenal tumor and the method has been widely employed by urologists since that time. Death from air emboli has been reported to occur occasionally and oxygen has been advised as a safer agent than air but death from oxygen emboli has also occurred. Recently Ruiz Rivas has described a technique of presacral insufflation which permits visualization of both kidneys and adrenals simultaneously and is thought to be safer than perirenal insufflation.

Renal aortography was introduced by dos Santos in 1929, but the technique employed sodium iodide and was not utilized widely. When safer contrast media became available Doss, Nelson and Parke Smith employed aortography and brought it into popular esteem. Today it is utilized in urology in many situations where it is desirable to demonstrate the vascular supply of the kidney and adrenal gland, and its usefulness in the field of vascular surgery has been firmly established.

Stewart of Los Angeles, California has recently observed that delayed cystograms and cystograms made during micturition will often reveal ureteral reflux not demonstrated by immediate cystograms in children who suffer from recurrent urinary infection. This technique has also demonstrated that significant dilatation of the ureter and renal pelvis observed on delayed cystograms can occur in children whose excretory urograms are entirely normal.

These latter contributions have tended to emphasize a modern trend in urology, as in all fields of medicine, toward the study of dynamic physiology rather than gross morphology. Now we are in the exciting dawn of the era of fluoroscopic image intensification and can look forward confident that the future will reveal a new understanding of urinary tract dynamics in both health and disease: *urology* is eagerly awaiting the new contributions of *radiology* to her sister specialty.

Department of Surgery
University Hospital
Ann Arbor, Michigan

WALTER H. UDE

1896–1956

DR. WALTER H. UDE, senior member of a group of radiologists in Minneapolis, died on February 10, 1956 at the age of fifty-nine. Dr. Ude was born in 1896 in Blue Earth County, Minnesota, where his father was pastor of a German Lutheran congregation. He attended public schools in Chatfield, Minnesota. After his return from World War I, in which he served overseas in the Artillery, he was employed for a time in a bank in his home community. Dr. Ude was respected for his business acumen by his professional colleagues and it may well be that this early banking experience was responsible for his insight into financial matters.

In 1925, Dr. Ude was graduated from the Medical School of the University of Minnesota. At that time he was elected to membership in Alpha Omega Alpha, honorary medical fraternity. Following his internship at Minneapolis General Hospital he entered immediately upon radiological training. He did graduate work at the University of Michigan under the late Dr. Preston Hickey in 1926. Returning to the Minneapolis General Hospital, he became the first trainee of his good friend, Dr. Leo G. Rigler. At the conclusion of his training, he was made Chief of the Department of Roentgenology at the Minneapolis General Hospital, where he remained in that capacity for fifteen years and where he was thereafter consultant to the Department until the time of his death. Dr. Ude was also Roentgenologist to St. Mary's Hospital in Minneapolis, a position which he had held since 1931.

Teaching appealed to Dr. Ude. He contributed greatly to the discussions at the weekly seminars and diagnostic conferences in radiology at the University of Minnesota Medical School, where he was Clinical Professor of Radiology. He went out of his way to befriend and encourage the younger men. His ideas, not only in the field of roentgen diagnosis but also in regard to general medical affairs, were provocative and stimulating. He will be deeply missed at future meetings.

Dr. Ude was an enthusiastic worker for the Minnesota and Hennepin County (Minneapolis) Tuberculosis Associations. In the early struggle for tuberculosis control in this state he played a prominent part in disseminating knowledge of proper roentgenologic methods for such control. He prized his membership in the Minnesota Trudeau Medical Society. However, from the standpoint of his published works, he will probably be best remembered for his contributions during the 1930's with Dr. J. A. Urner on the diagnosis of placenta previa.

Medical organizations received a great deal of attention from Dr. Ude. He was an active worker in his county medical society, a fellow of the American College of Radiology, a Diplomate of the American Board of Radiology, and a member of the American Roentgen Ray Society. From 1946 to 1956 he was Counsellor of the Radiological Society of North America for the state of Minnesota and shortly before his death he was elected vice-president of the Radiological Society of North America.

In addition to his duties for medical groups and to a busy practice, he found time to travel extensively. Since 1947 he had traveled in Europe for two months annually, with the exception of one year. It was on a trip with Mrs. Ude, who is his only close survivor, that his sudden death occurred. This took place in Honolulu, Hawaii, and was presumably due to acute myocardial infarction. Through his death, radiology has lost an enthusiastic and forthright practitioner.

J. P. Medelman, M.D.

THOMAS DIGBY WHEELER
1892–1955

DIGBY WHEELER died suddenly on a train on September 20, 1955, while returning from Philadelphia, where he had just been made a Fellow of the International College of Surgeons.

He was born in Brantford, Ontario, and graduated in Arts from the University of Toronto in 1913. He then traveled west and in 1916 received his M.D., C.M. from the Manitoba Medical College in Winnipeg. After serving with the Royal Canadian Army Medical Corps in World War I, he returned to Winnipeg where he resided until his death. In 1919 he was appointed to the Faculty of Medicine as demonstrator and lecturer in anatomy. A few years later

he turned to radiology and in 1947 he became the first Professor of Radiology in the University of Manitoba. He retired from this post in 1953 with the rank of Professor Emeritus.

During his long, busy career he held many offices including President of the Canadian Association of Radiologists, President of the Winnipeg Medical Society, Treasurer of the College of Physicians and Surgeons, Manitoba, and Treasurer of the Manitoba Medical Service. He was a Fellow of the Faculty of Radiologists, London, a Fellow of the Royal College of Physicians and Surgeons, Canada, and a Fellow of the American College of Radiology. At the time of his death he was head of the radiology departments of St. Boniface, Misericordia, Grace, Victoria and Shriners' Hospitals in Winnipeg, as well as consulting radiologist to the Department of Veterans' Affairs and the Canadian National Railway.

Digby was a man of boundless energy and his activities were by no means confined to medicine. He was an ardent golfer and horticulturist and the grounds of his home were for many years a show place during the summer months. He found music a great source of pleasure and in 1953 and 1954 he was President of the Winnipeg Symphony Orchestra. His knowledge of composers and their works was extensive and he had a large record library.

He is survived by his wife, the former Eleanor Mitchell.

Arthur E. Childe, M.D.

JOHN McGREGOR BARNES
1899–1956

JOHN McGREGOR BARNES died in Cambridge, Maryland, on January 1, 1956, following a prolonged illness which had necessitated his resignation as Chief of the Radiology Service of the Millard Fillmore Hospital, Buffalo, New York. He had served in this capacity from July, 1930, until his resignation in September, 1954, when he was appointed consultant.

He was born in Washington, D. C. on March 5, 1899, and completed his early schooling there. During World War I he served as a seaman. His medical education was obtained at the University of Michigan

where he graduated in 1924, followed by an internship at the Naval Hospital, Norfolk, Virginia. He returned to Michigan for his radiology training during the years 1927 to 1930. Shortly after completion he went to the Millard Fillmore Hospital as Chief of the Radiological Service.

John Barnes will be remembered as an indefatigable worker by the members of the hospital staff whom he served for so many years. No problem presented too great a challenge to him and he would bend every effort towards its solution, no matter how difficult. His father had been a general practitioner in Washington, D. C. With this background, he was most sympathetic to the problems of the general practitioner. He was a good teacher, and the staff learned and realized soon after his arrival how necessary good radiology was to the understanding and solving of the problems of clinical medicine. His constant help and advice will long be cherished by the staff.

He was an ardent fisherman and huntsman. One of his pleasant avocations was raising prize springer spaniels.

Dr. Barnes was certified by the American Board of Radiology in 1932. He belonged to the local, county, state and national medical societies, the American Roentgen Ray Society, the Radiological Society of North America and was a Fellow of the American College of Radiology.

Dr. Barnes is survived by his wife, the former Rita Barry; a son, John Jr.; two daughters, Mrs. Clinton Ducassa and Mrs. Alvin LaRoche and five grandchildren.

Norman Heilbrun, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF RADIOLOGICAL SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Statler Hotel, Los Angeles, Calif., Sept. 25–28, 1956.

American Radium Society
Secretary, Dr. R. E. Fricke, Mayo Clinic, Rochester, Minn. Annual meeting: Shamrock Hotel, Houston, Texas, April 9–11, 1956.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 2–7, 1956.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois. Annual meeting: 1956, to be announced.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich. Annual Meeting: June 11–15, 1956, Chicago, Illinois.

Eighth International Congress of Radiology
Secretary General, Dr. José Noriega, Calle del Oro 15, Mexico 7, D. F. Meets Mexico City, July 22–28, 1956.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. J. J. Riordan, 550 W. Thomas Rd., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. J. A. Norton, 843 Donaghey Bldg., Little Rock, Ark. Meets every three months and also at time and place of State Medical Association.

Association of University Radiologists
Secretary, Dr. Robert J. Bloor, 260 Crittenden Blvd., Rochester 20, New York. Annual Meeting, May 19–20, 1956 at the University of Rochester, N.Y.

Atlanta Radiological Society
Secretary, Dr. Charles M. Silverstein, 3254 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Blockly Radiological Society
Secretary, Dr. Samuel Finkelman. Annual dinner: May, 1956.

Brooklyn Radiological Society
Secretary, Dr. Theodore Kamholtz, 152 Clinton Street, Brooklyn, N. Y. Meets first Thursday of each month October through May.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Clayton G. Weig, 135 Linwood Ave., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary, Dr. Arthur R. Cohen, 41 S. Grant Ave., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, November, January, March and May at Fort Hayes Hotel, Columbus, Ohio.

Central Society of Nuclear Medicine
Secretary, Dr. Robert S. Landauer, Radiation Center Building, 1903 West Harrison St., Chicago 12, Ill.

Chicago Roentgen Society
Secretary, Dr. E. Burns Lewis, 670 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month, October to April inclusive at the Sheraton Hotel.

Cleveland Radiological Society
Secretary, Dr. A. S. Tucker, 2020 East 93 St., Cleveland 6, Ohio. Meetings at 7:00 P.M. on fourth Monday of each month from October to April at Tudor Arms Hotel.

Colorado Radiological Society
Secretary, Dr. Dorr H. Burns, 1776 Vine St., Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. T. J. Crowe, 53 Center St., Northampton, Mass. Meets second Friday October and April.

Dallas-Fort Worth Radiological Club
Secretary, Dr. A. H. Keene, 3707 Gaston Ave., Dallas, Texas. Meets monthly, third Monday, at Greater Fort Worth International Airport at 6:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. F. Lang, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, Oct. through May at David Whitney House, 4421 Woodward Ave., at 6:30 P.M.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. D. H. Gahagen, 320 Sweet Bldg., Fort Lauderdale, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. B. H. Malone, 1406 Reynolds St., Brunswick, Ga.

Greater Miami Radiological Society
Secretary, Dr. A. S. Capi, 300 N. 20th Ave., Hollywood, Fla. Meets monthly third Wednesday at 8 P.M. at various South Florida Hospitals.

Greater St. Louis Radiological Society
Secretary, Dr. Sam J. Merenda.

Houston Radiological Society
Secretary, Dr. Leslie L. Lemak, 616 Medical Arts Bldg., Houston 2, Texas. Meets fourth Monday each month, Meeting Room, Doctors' Club of Houston.

Idaho State Radiological Society
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. C. A. Stayton, 313 Hume-Mansur Bldg., Indianapolis 4. Meets first Sunday in May and during fall meeting of Indiana State Medical Association.

Iowa Radiological Society
Secretary, Dr. James T. McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

* Secretaries of societies are requested to send timely information promptly to the Editor.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. A. M. Cherner, Hays, Kansas. Meets in spring with State Medical Society, and in winter on call.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. David Shapiro, 217 East Chestnut St., Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

KINGS COUNTY RADIOLOGICAL SOCIETY
Secretary, Dr. Solomon Maranov, 1450 51st St., Brooklyn 19, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Richard A. Kredel, 65 North Madison Ave., Pasadena, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building, Los Angeles.

MAINE RADIOLOGICAL SOCIETY
Secretary, Dr. W. A. Russell, Augusta General Hospital, Augusta, Maine. Meets in June, October, December and April.

MARYLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Maryland.

MEMPHIS ROENTGEN SOCIETY
Secretary, Dr. B. E. Greenberg, 294 Annella St., Memphis 11, Tenn. Meets first Monday of each month at John Gaston Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

MID-HUDSON RADIOLOGICAL SOCIETY
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. R. W. Byrne, 3321 N. Maryland Ave., Milwaukee 1, Wis. Meets monthly on fourth Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. O. J. Baggenstoss, 1953 Medical Arts Bldg., Minneapolis, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

MISSISSIPPI RADIOLOGICAL SOCIETY
Secretary, Dr. James M. Packer, 621 High St., Jackson, Miss. Meets third Thursday of each month at Hotel Edwards, Jackson, at 6:00 P.M.

MONTANA RADIOLOGICAL SOCIETY
Secretary, Dr. John Stewart, 1105 Frederick Lane, Billings, Montana. Meets at least once a year.

NASSAU RADIOLOGICAL SOCIETY
Secretary, Dr. Frances Behrendt, 19 Clinton Rd., Garden City, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. J. F. Kelly, Jr., 816 Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Raymond A. Dillon, 24 Wedgemere Ave., Winchester, Mass. Meets third Friday of each month, October through May, at Hotel Commander, Cambridge, Mass.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. M. H. Poppel, 303 E. 20th St., New York 3, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. William H. Sprunt, North Carolina Memorial Hospital, Chapel Hill, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Marianne Wallis, St. Joseph's Hospital, Minot, N. Dak. Meetings by announcement.

NORTH FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. Marvin Harlan Johnston, Five Points Medical Center, Jacksonville, Fla. Meets quarterly in March, June, September and December.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY
Secretary, Dr. Robert R. Wadlund, Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY
Secretary, Dr. H. B. Stewart, 2920 Capitol Ave., Sacramento, Calif. Meets at dinner last Monday of each month, September to June.

OHIO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. John R. Hannan, 10515 Carnegie Ave., Cleveland 6, Ohio. Annual meeting, Deshler-Hilton Hotel, Columbus, Ohio, May 12–13, 1956.

OKLAHOMA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY
Secretary, Dr. N. L. Blinė, 210 Jackson Tower, Portland 5, Ore. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets annually in May.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. Walter P. Bitner, 234 State Street, Harrisburg, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. H. M. Stauffer, Temple University Hospital, Philadelphia 40, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. N. Tannehill, 500 Penn Ave., Pittsburgh 22, Pa. Meets second Wednesday of month, October through June at Hotel Roosevelt.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF GREATER CINCINNATI
Secretary, Dr. R. J. Neubauer, 831 Carew Tower, Cincinnati, Ohio. Meets monthly from September to May on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

RADIOLOGICAL SOCIETY OF HAWAII
Secretary, Dr. George W. Henry, 1133 Punchbowl, Honolulu, T. H. Meets third Monday evening of each month at designated hospitals.

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY
Secretary, Dr. E. H. Stratemeier, Jr., 1010 Rialto Building, Kansas City 6, Mo. Meets last Friday of each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA
Secretary, Dr. W. S. Neal, 602 Pere Marquette Bldg., New Orleans, La. Meets annually during Louisiana State Medical Society Meeting.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. G. G. Green, 601 Grand Ave., Asbury Park, N. J. Meets at Atlantic City at time of State Medical Society and in November in Newark, N. J.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA
Secretary, Dr. J. B. Irwin, 1831 Fourth Ave., San Diego, Calif.

Richmond County Radiological Society
Secretary Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga. Meets first Thursday of each month at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Henry H. Forsyth, Jr., 40 Meigs St., Rochester, N. Y. Meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. John H. Freed, 4200 East Ninth St., Denver 20, Colo.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Jr., 3720 Washington Ave., St. Louis 8, Mo. Meets fourth Wednesday each month, except June, July, Aug. and Sept.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brooke Army Medical Center Officers Mess second Wednesday of each month.

San Diego Radiological Society
Secretary, Dr. J. C. Asher, 2001 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. Howard L. Steinbach, University of California Medical Center, San Francisco 22, Calif. Meets quarterly at Grison's Steak House.

Section on Radiology, California Medical Association
Secretary, Dr. A. R. Wilson, 540 North Central Ave., Glendale 3, Calif.

Section on Radiology, Connecticut State Medical Society
Secretary, Dr. J. Burbank, Meriden Hospital, Meriden, Conn. Meetings are held bi-monthly.

Section on Radiology, Medical Society of the District of Columbia
Secretary, Dr. F. V. Schumacher, 1835 Eye St., N.W., Washington 6, D. C. Meets Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M. September to May inclusive.

Society of Nuclear Medicine
Secretary, Dr. Robert G. Moffat, B. C. Cancer Institute, 2656 Heather Street, Vancouver 9, Canada. Annual Meeting, Salt Lake City, Utah, June 21–23, 1956.

South Bay Radiological Society
Secretary, Dr. T. N. Foster, 630 E. Santa Clara St., San Jose, Calif. Meets second Wednesday of each month.

South Carolina Radiological Society
Secretary, Dr. S. W. Lippincott, 103 Rutledge Ave., Charleston, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Southwestern Radiological Society
Secretary, Dr. Gordon Black, Suite 2-A, El Paso Medical Center, 1501 Arizona, El Paso, Texas. Meets second Tuesday of each month.

Tennessee Radiological Society
Secretary, Dr. G. K. Henshall, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. J. E. Miller, Baylor Hospital, Dallas, Texas. Next Meeting, Corpus Christi, Texas, Jan. 18–19, 1957.

Tri-State Radiological Society
Secretary, Dr. Robert E. Beck, 600 Mary St., Evansville, Ind. Meets last Wednesday of Oct., Jan., March and May, 8:00 P.M. at Elks' Club in Evansville.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

Upper Peninsula Radiological Society
Secretary, Dr. A. Gonty, Menominee, Mich. Meets quarterly.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets fourth Wednesday in January, March, May, September and November at Holy Cross Hospital.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Eva L. Gilbertson, 1317 Marion St., Seattle 4, Wash. Meets fourth Monday of each month from September through May at 610 Pine St., Seattle.

West Virginia Radiological Society
Secretary, Dr. W. Paul Elkin, 515 Medical Arts Bldg., Charleston, W. Va. Meets concurrently with annual meeting of West Virginia State Medical Society; other meetings arranged by program committee.

Westchester Radiological Society
Secretary, Dr. M. G. Priestman, New Rochelle Hospital, New Rochelle, N. Y. Meets on third Tuesday of January and October and on two other dates.

Wisconsin Radiological Society
Secretary, Dr. W. W. Moir, 309 Geele Ave., Sheboygan, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. J. T. English, 2000 Van Ness Ave., San Francisco 9, Calif. Meets monthly, third Thursday at 7:45 P.M., Lane Hall, Stanford University Hospital.

Cuba, Mexico, Puerto Rico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiología, A. C.
Calle del Oro No. 15, Mexico 7, D. F.
Secretary General, Dr. Guillermo Santín. Meets first Monday of each month.

Asociación Puertorriqueña de Radiología
Secretary, Dr. Rafael A. Blanes, P. O. Box 9067, Santurce, Puerto Rico.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

Association of Radiologists of the Province of Quebec
Secretary, Dr. Isadore Sedlezky, 3755 Cote St. Catherine Rd., Montreal, Que. Meets four times a year.

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1

Faculty of Radiologists
Honorary Secretary, Dr. R. A. Kemp Harper, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. Guillaume Gill, Suite 305, 1555 Summerhill Avenue, Montreal 25, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALES
General Secretary, Dr. Ls Ivan Vallée, 1058 rue St-Denis, Montreal 18, Canada. Meets third Saturday each month.

COLLEGE OF RADIOLOGISTS (AUSTRALIA AND NEW ZEALAND)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

SOUTH AMERICA

ASOCIACION ARGENTINA DE RADIOLOGIA
Secretary, Dr. Lidio G. Mosca, Avda. Gral. Paz 151 Córdoba, Argentina. Meetings held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, JUNTA CENTRAL, BUENOS AIRES
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL LITORAL, SEDE, ROSARIO
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL SUR, SEDE, LA PLATA
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL CENTRO SEDE, CÓRDOBA
President, Prof. Dr. David L. Caro, Corro 86, Córdoba. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL NORTE, SEDE, TUCUMAN
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DE CUYO SEDE, MENDOZA.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA
Secretary, Dr. Nicola Caminha, Av. Mem. de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD COLOMBIANA DE RADIOLOGIA
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6° piso, Bogota, Colombia. Meets last Thursday of each month.

SOCIEDAD ECUATORIANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Enrique Ortega Guzmán, Casilla 4719, Guayaquil, Ecuador.

SOCIEDAD PERUANA DE RADIOLOGIA
Secretary General, Dr. Amador Holgado V. Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGÍA, CANCEROLOGÍA Y FÍSICA MÉDICA DEL URUGUAY
Secretary General, Dr. Roberto Francois, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

SOCIEDAD VENEZOLANA DE RADIOLOGÍA
Secretary, Dr. Otto Paz, Centro Médico, Caracas, Venezuela. Meets monthly third Friday at Colegio Médico del Distrito Federal, Caracas.

CONTINENTAL EUROPE

AUSTRIAN ROENTGEN SOCIETY
President, Dr. Konrad Weiss, Mariannengasse 10, Vienna 9, Austria. Meets second Tuesday of each month in Allgemeine Poliklinik.

SOCIÉTÉ BELGE DE RADIOLOGIE
General Secretary, Dr. S. Masy, 256 Chaussée de Wavre, Heverlee-lez-Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

SOCIÉTÉ FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALE, and its branches: SOCIÉTÉ DU SUD-OUEST, DU LITTORAL MÉDITERRANÉEN, DU CENTRE ET DU LYONNAIS, DE L'OUEST, DE L'EST, ET D'ALGER ET D'AFRIQUE DU NORD
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX°, France.

CESKOSLOVENSK SPOLEČNOST PRO RËNTGENOLOGII A RADIOLOGII V PRAZE
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

DEUTSCHE RÖNTGEN-GESELLSCHAFT
Secretary, Dr. med. Peter Kröker, Evangelisches Krankenhaus, Huyssens Stiftung, (22a) Essen.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

NEDERLANDSE VERENIGING VOOR ELECTROLOGIE EN ROENTGENOLOGIE
Secretary, Dr. B. J. Rethmeier, Bornsestraat 378, Almelo, Netherlands.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Juljusz Borejko, 59 Nowogrodzka St., Warsaw, Poland.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

WROCLAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. R. Marciniak, Akad. Medyczna Wroclaw, 68 Curie-Sklodowska St., Wroclaw, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wroclaw.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S.I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ-SUISSE DE RADIOLOGIE)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

INDIA

INDIAN RADIOLOGICAL ASSOCIATION
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

The list of Meetings of Radiological Societies is published in every other issue of the JOURNAL.

LOS ANGELES INVITES RADIOLOGISTS

The Section on Radiology of the Los Angeles County Medical Association would like to offer hospitality and entertainment to all foreign radiologists and their families who intend to pass through Los Angeles on their way home after attending the Eighth International Congress of Radiology. No scientific conferences or meetings are planned. Sight-seeing tours in small groups, visits to movie studios, entertainment in the homes of local radiologists, and visits with them in their offices and departments constitute the planned features.

A cordial invitation is extended to all radiologists and their families from outside of the United States, who are participating in the Congress to be our guests on July 30 and July 31, 1956, in Los Angeles, California.

For particulars write to Stefan P. Wilk, M.D., Secretary, University of California Medical Center, Los Angeles 24, California.

THE ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The next meeting of the Rocky Mountain Radiological Society will be held in Denver, Colorado, at the Shirley-Savoy Hotel on August 16, 17, and 18, 1956. A detailed program will be published in a future issue of the Journal.

THE NINTH ANNUAL CONFERENCE ON ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

The Ninth Annual Conference on Electrical Techniques in Medicine and Biology will be held at the Governor Clinton Hotel in New York City on November 7, 8, and 9, 1956.

Titles and brief abstracts for proffered papers may be submitted to the Conference Chairman, E. Dale Trout, General Electric Company, X-Ray Department, Milwaukee 1, Wisconsin.

JOSEPH C. AUB HONORED

The 1956 recipient of the Bertner Foundation Award was Joseph C. Aub, M.D., Professor of Medical Research, Harvard Medical School, and director of medical laboratories at the Collis P. Huntington Memorial Hospital.

Established in 1950, the award in honor of the late Dr. E. W. Bertner, first acting director of M. D. Anderson Hospital and Tumor Institute and the first president of the Texas Medical Center, is presented annually for outstanding contribution in the field of cancer research.

Dr. Aub received the Award for his inspirational teaching, his untiring work for institutional and individual grants, and his research in metabolics which established methods which are the foundation of present day metabolic studies.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Grenzen des Normalen und Anfänge des Pathologischen im Röntgenbilde des Skelettes. Von Prof. Dr. A. Köhler, und Doz. Dr. E. A. Zimmer. Cloth. Price, DM 88.—. Pp. 672, with 1282 illustrations. Georg Thieme, Herdweg 63, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1953.

This standard work in radiologic literature, started with Prof. Alban Köhler's booklet in 1910, has truly grown up with this 9th edition by Dr. E. A. Zimmer. The revision has been so extensive that the author has indicated in the text the observations of Köhler's which have been retained.

The book is richly illustrated (the reproductions of films are in the positive) and liberally supplied with references (chiefly from the European literature). Though the book will serve mainly as a reference work, the text is clearly written, easily read, and communicates its ideas with facility. The subject matter closely follows the limits set by the title.

Like its predecessors, this edition will be a welcome addition to the working library of any physician who concerns himself with the roentgenographic appearance of the skeleton.

Henry G. Moehring, M.D.

Clinical Radiology of the Ear, Nose and Throat. By Eric Samuel, M.D. (Lond.), F.R.C.S. (Eng.), F.F.R. (Lond.), D.M.R.E. (Camb.), Late Hon. Radiologist the Middlesex Hospital, London; Late Radiologist Royal National Ear, Nose and Throat Hospital, London; Lieut.-Col. R.A.M.C., Advisor in Radiology to the Army; Sometime Nufield Foundation Fellow and Duchess of Bedford Research Fellow, the Middlesex Hospital, London. Cloth. Pp. 339, with 320 illustrations. Paul B. Hoeber, Inc., 49 East 33rd Street, New York 16, New York, 1952.

This review of a now well-thumbed volume is not based on cursory reading and an estimate of probable usefulness. If the following comments appear too belatedly to suit the publisher's initial interest in stimulating wide immediate distribution, they may yet serve a worthwhile purpose by commending to clinical radiologists a thoroughly worthwhile and dependable companion, well stocked with important and reliable information bearing upon a phase of their work which requires a high degree of exactitude.

The text is made up of a pleasing combination of pertinent anatomical, clinical and radiological considerations of very considerable practical importance. While one might wish that the description of technical procedures had been handled in a single section, with even freer use of line drawings to depict standard and less commonly needed projections with all roentgen ray beam angles clearly expressed with respect to the "radiographic base line" or the sagittal plane, this phase of the subject has been presented adequately and well. The author's preference for positive reproductions has been plausibly explained, though perhaps without converting many American readers.

Of the three sections, the second, which deals with the auditory apparatus is the most replete and the most helpful. It serves as a dependable guide and counselor in the apprehension and evaluation of abnormalities involving the deep-seated structures of the middle and inner ear and clarifies the often bewildering radiologic appearance of significant anatomical landmarks as seen both in health and disease.

The author has provided for the otolaryngologist and radiologist as a clinical team a much used reference work which each member can understand and respect. The publisher has employed careful workmanship and materials of fine quality to produce this pleasing and durable volume.

Fred J. Hodges, M.D.

The Auger Effect and Other Radiationless Transitions. By E. H. S. Burhop, Reader in Physics, University of London (University College). Cloth. Price, $5.50. Pp. 188, with 49 illustrations and 24 tables. Cambridge University Press, American Branch, 32 East 57th Street, New York 22, New York, 1952.

This volume of the Cambridge University

Press is part of the well known Cambridge Monographs on Physics and consists of slightly less than two hundred pages covering eight chapters. Of these, the first three cover the historical aspects, the theory and the experimental study of the phenomenon, whereas the remaining ones discuss its importance in the interpretation of roentgen ray spectra, internal conversion of gamma rays, internal pair production, the capture of mesons by nuclei and the radiationless transitions in atomic and molecular spectra. Some of these fields are very active at the present moment.

Dealing with a highly specialized subject, the author has kept its treatment concisely clear, yet highly readable by relying on good figures and informative tables. A bibliography of about 300 articles covers most of the important work published until December, 1950.

L. D. Marinelli

Multiple Myeloma. By I. Snapper, M.D., Director of Medical Education, Cook County Hospital, Chicago Hospital, Chicago, Illinois; Formerly, Director of Medical Education, Mount Sinai Hospital, New York, New York; Louis B. Turner, M.D., Research Assistant in Medicine, Mount Sinai Hospital, New York, New York; and Howard L. Moscovitz, M.D., Resident, Second Medical Service, Mount Sinai Hospital, New York, New York. Cloth. Price, $6.75. Pp. 168, with 43 illustrations and 15 tables. Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, New York, 1953.

This well-written monograph fully merits its popularity. Each of its chapters is brief, informative and to the point. The discussions of the clinical manifestations and of the pathology, including the laboratory features, are excellent.

It may be of interest to enumerate some of the roentgenologic observations that are discussed.

In many patients recurrent infections simulating bronchopneumonia actually represent recurrent small pulmonary infarctions which have become secondarily infected.

The roentgen appearance of intrathoracic tumor, especially metastatic tumor, may be simulated by myelomatous tumors arising in the thoracic cage. Symptoms of the nervous system develop in about 40 per cent of patients, usually from direct involvement of the nervous system by extension of myeloma from neighboring bones or collapsed vertebrae, or as the result of peripheral neuritis. Roentgen changes in bone include innumerable, punched out, sharply demarcated areas of destruction, very rarely with any osteoblastic reaction. In addition to the frequent involvement of the spine, ribs, sternum, clavicle, skull and the bones of the extremities near the pelvis or shoulder girdle, the authors in their series of 97 patients, found involvement of the mandible in 12, generalized demineralization without discrete lesions in 7, and no demonstrable lesions in any bone in 5.

The diagnosis of solitary myeloma can be accepted in only a few of the cases reported in the literature. The roentgen appearance is that either of a giant cell tumor or of a destructive bone lesion, nearly always localized in the intramedullary cavity. A solitary lesion, having many septa, which is localized in a flat bone, is more likely to be a solitary myeloma than a giant cell tumor. Such a diagnosis should be confirmed by biopsy if possible. The presence in the sternal marrow of myeloma cells, however, indicates that the process is part of a generalized myelomatosis. In its evolution, the disease often first appears to have a single focus of myeloma tissue. As a consequence, some doubt is cast on the multicentric theory of origin of multiple myeloma.

Bence Jones proteinuria has never been reported in extramedullary plasmacytomas without skeletal involvement. The occurrence of Bence Jones proteinuria in disease other than multiple myeloma is questioned.

In the differential diagnosis one may consider skeletal metastatic carcinoma, postmenopausal and senile osteoporosis, hyperparathyroidism and giant cell tumor. Except in rare instances, if the serum alkaline phosphatase remains elevated in the absence of a gross pathologic fracture or of liver disease, the diagnosis of multiple myeloma should be questioned.

Although the tumor is radioresistant, roentgen therapy may be given for palliation of a localized plasmacytoma that is causing pain. Radioactive phosphorus has not yielded beneficial results. A few cases have been reported in which favorable results have been obtained with urethane, and in which roentgenograms have revealed an increase in bone density with recalcification of osteolytic areas.

The photographs and photomicrographs are of good quality, and the reproductions of the roentgenograms are excellent. A select bibliog-

raphy of 217 titles and an adequate index are appended. From every point of view, this monograph can be highly recommended.

S. E. Gould, M.D.

Physical Foundations of Radiology. By Otto Glasser, Professor of Biophysics and Head of Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio; Edith H. Quimby, Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York; Lauriston S. Taylor, Chief, Atomic and Radiation Physics Division, National Bureau of Standards, Washington, D. C.; and J. L. Weatherwax, American Oncologic Hospital and Graduate School of Medicine, University of Pennsylvania, Philadelphia. Second edition, revised and enlarged. Cloth. Price, $6.50. Pp. 581, with 112 illustrations and 68 tables. Paul B. Hoeber, Inc., 49 East 33rd Street, New York 16, New York, 1952.

This volume represents the second edition of the book of the same title which appeared first in 1944. Its aim remains essentially the same; namely, to fill the educational needs in radiological physics of physicians preparing to enter the profession and of those already in the specialty wishing to review the subject.

The treatment of the subject matter remains also elementary and free of cumbersome mathematical formulas; the revision, however, has been considerable, as necessitated by the rapid developments taking place in the intervening years. Of twenty chapters, the first is devoted to historical developments and the next four deal essentially with basic physics, *i.e.*, fundamental concepts of matter, radiation, electricity and magnetism, as well as with the pertinent interactions of radiation and matter.

The following four sections are concerned with roentgen ray production and means of accomplishing it.

Chapter X consists of discussion of the physical principles involved in roentgenographic diagnostic procedures. The next three are concerned with measurements of quantity and quality of roentgen rays for purposes of both standardization of machines as well as for the purpose of evaluating tissue doses in roentgen therapy.

Chapter XIV elucidates the phenomena of radioactivity, whereas the next two take up the measurement of gamma rays and dosage calculation in radium therapy.

Chapters XVII and XVIII cover the measurement of radiation from radioactive isotopes and of the dosages pertinent to their distribution in tissue.

The final two chapters treat briefly the dependence of biological reaction on quality and time factors and more extensively the problem of protection in radiological installations.

A generous appendix of about sixty pages of depth dose tables ensues.

The authors, though pressed by other duties, have succeeded in maintaining the high standards attained in the first edition and should be commended for their effort in behalf of the profession.

L. D. Marinelli

Gynäkologische Röntgendiagnostik. Von Prof. Dr. Günter K. F. Schultze, and (second edition) Dozent Dr. med. habil. Joachim Erbslöh. Cloth. Price, DM 59.—. Pp. 399, with 239 illustrations. Ferdinand Enke Verlag, Hasenbergsteige 3, (14a) Stuttgart-W., Germany, 1954.

Roentgenologists and gynecologists seeking an exhaustive treatise on hysterosalpingography will welcome this newly revised and expanded edition of "Gynäkologische Röntgendiagnostik." The first edition, written by the late Prof. Günter Schultze appeared in 1939. The present edition was prepared by Dr. Joachim Erbslöh. It incorporates the most recent developments in the field and hence provides a definitive exposition of the advantages and shortcomings of hysterosalpingography in gynecologic diagnosis in general and for the investigation of female sterility in particular.

The material is presented in two sections. The first section deals extensively with the technique of hysterosalpingography, the highly variable patterns observed in uterosalpingograms under physiologic and pathologic conditions and, finally, the risks and dangers of this technique. The second portion of the book describes in detail the diagnostic features of the hysterosalpingogram in diseases of the uterus, cervix, and tubes, as well as in ovarian tumors, uterine malignancy and in pregnancy.

The text is beautifully illustrated with 239 well-selected hysterosalpingograms.

Harold C. Mack, M.D.

Grenz Ray Therapy. Principles, Methods, Practice. By Gustav Bucky, M.D., Clinical Professor of Dermatology Emeritus, New York University; and Frank C. Combes,

M.D. Professor of Dermatology and Syphilology, New York University Postgraduate Medical School, and Director of Dermatology and Syphilology, Bellevue Hospital. Cloth. Price $8.50. Pp. 204, with 62 illustrations. Springer Publishing Company, Inc., 44 East 23rd Street, New York 10, New York, 1954.

This book has been written for the purpose of acquainting the physician with the place grenz rays should, in the authors' opinion, occupy in medicine. Its publication was delayed because the writers wanted to accumulate sufficient clinical material to permit a true evaluation of the problem.

In the first section of this volume the evolution of superficial roentgen therapy, origin of grenz ray therapy, ionization in biologic materials, and special considerations in grenz ray therapy are discussed by Bucky. There is also a brief section by Glasser and Steinitz on physics and technique of grenz irradiation and by Goldzieher on histologic changes of the skin.

In the second section, the clinical part, Bucky outlines the technique of grenz ray therapy and then describes the skin manifestations following its use. There are also contributions by Combes (grenz ray therapy in skin diseases), Sagher (grenz ray therapy in tropical diseases), Brodsky (grenz ray therapy in oral lesions) and Sagher and Landau (grenz ray therapy in ophthalmology). Although each chapter has its own individual set of references there is an extensive classified bibliography at the end of the book. The illustrations are well chosen and of good quality. Whether or not one wishes to share completely the enthusiasm of the editors regarding the value of grenz ray therapy in medical practice, the book makes interesting reading.

Ernst A. Pohle, M.D.

Clinical Roentgenology. Volume III. The Lungs and the Cardiovascular System, Emphasizing Differential Considerations. By Alfred A. de Lorimier, M.D., Radiologist, Saint Francis Memorial Hospital, San Francisco, California; Henry G. Moehring, M.D., Radiologist, Duluth Clinic, Duluth, Minnesota; John R. Hannan, M.D., Radiologist, Cleveland, Ohio. Cloth. Price, $20.50. Pp. 508, with numerous illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1955.

The third volume of this textbook deals with diseases of the chest, including the thoracic cage, diaphragm, mediastinum, pleura, lungs, heart and great vessels. As in the previous two volumes each chapter reviews the basic pathologic processes, roentgen manifestations, clinical and laboratory findings and differential diagnosis of each of the diseases presented; and as in the previous volumes, the emphasis is again on brevity and clarity rather than completeness. The limitations of the roentgenologic method are brought out, and the correlation, or lack of correlation, with clinical findings is discussed with competence. The authors have based their presentation mainly on the well-established methods of roentgen examination —"plain" films and fluoroscopy—but the more complex procedures such as laminagraphy and angiocardiography are also used to illustrate the pathologic conditions explained in the text. A wealth of well chosen illustrations accompanies the description; but since most of them are reproductions of full 14×17 inch teleroentgenograms, significant details are not always easily recognized by the reader. The present flowering of thoracic surgery places on the roentgenologist a responsibility for accurate segmental localization of any pulmonary lesion, and good diagrams of the bronchopulmonary segments would add to the value of the book. It is hoped that future editions may include magnified pictures of diseased pulmonary parts and a few drawings of the ramifications of the bronchial tree.

Brevity is a cardinal virtue of *Clinical Roentgenology*, although occasionally it upsets the balance in this volume. For instance, glycogen disease of the heart is assigned three pages, while sarcoidosis and all the fungus infections are given only one page each.

Most pulmonary roentgen images are difficult to correlate with their anatomic and physiologic foundations. To sort and classify them is a considerable task, probably an impossible one, at this stage of our knowledge. Within the limitations imposed by the subject the authors have succeeded in presenting a well organized and clearly written textbook, sober and critical in approach and of considerable didactic value.

Albert Oppenheimer, M.D.

Symposium on Physiological Effects of Radiation at the Cellular Level. Given at Research Conference for Biology and Medicine of the Atomic Energy Commission sponsored by The Biology Division, Oak Ridge National Laboratory, Oak Ridge,

Tennessee, April 12, 13, 1951. Paper. This monograph is available, free of charge, to scientific investigators in the Radiation Biology field. Pp. 233, with numerous illustrations. Oak Ridge National Laboratory, Post Office Box P, Oak Ridge, Tennessee, 1952.

This volume, Supplement 2, Vol. 39 of the Journal of Cellular and Comparative Physiology, is a collection of nine papers presented at the Fourth Annual Biology Research Conference sponsored by the Biology Division of the Oak Ridge National Laboratory in cooperation with the Atomic Energy Commission and the Oak Ridge Institute of Nuclear Studies. An appreciable amount of the stimulating discussion is reproduced to great advantage to the reader. The subject matter is rather scattered and does not offer even a tenuously organized treatment of any particular aspect of radiation effects at the cytological level. Rather, it is partly a collection of reports on expertly conducted experiments on radiation-induced phenomena, such as cell permeability, and partly a collection of dissertations by biologists and biochemists, eminent in their specialties, of their initial thoughts on possible approaches to the clarification of some radiological phenomena. Despite the undoubted importance of the direct contributions on the part of the experimentalists, it is perhaps this portion of the Symposium that is likely to prove most stimulating to the reader. The latter cannot lightly dismiss the wealth of ancillary knowledge reviewed and the delineation of some areas where much fundamental biological information is needed before any radiobiological understanding can be achieved.

L. D. Marinelli

Actions Chimiques et Biologiques des Radiations. Edited by M. Haissinsky. Paper. Price, 2.800 Fr. Pp. 254, with 70 illustrations. Masson et C^ie^, Éditeurs, 120 boulevard Saint-Germain, Paris (VI^e^), France, 1955.

This short but excellent volume, consisting of articles by L. H. Gray, M. Lefort, and W. M. Dale, summarizes the basic chemical and physical principles underlying modern radiation biology in a clear and concise manner. The paper by Gray, which deals primarily with the fundamental physical approach to radiation action, is particularly outstanding and can be read with profit by any student or worker in the field. Lefort has brought together much of the recent experimental material in the radiation chemistry of aqueous systems, complete with tables. An interesting discussion of modern trends in radiation biochemistry by Dale completes the treatment.

These papers give a good introduction to the contemporary literature of radiation biology. They are, however, more than brief reviews and are concerned primarily with the basic mechanisms and phenomena of radiation biology rather than with a simple enumeration of current results. A minor inconvenience is the lack of a complete bibliography at the end of each article. In spite of some language difficulties, which may be expected for the American student, in the continuing absence of a suitable formal introductory textbook on radiobiology, this volume should make a very suitable starting point for a study of the action of radiation on biological and biochemical systems. Both editor and authors are to be congratulated for an outstanding accomplishment.

John S. Kirby-Smith, Ph.D.

BOOKS RECEIVED

Autoradiography in Biology and Medicine. By George A. Boyd, Director Arizona Research Laboratories, Phoenix, Arizona. Formerly, Professor of Biophysics, University of Tennessee, and Senior Scientist, Oak Ridge Institute of Nuclear Studies. Cloth. Price, $8.80. Pp. 399, with 98 illustrations. Academic Press Inc., Publishers, 125 East 23 Street, New York 10, New York, 1955.

Segmental Anatomy of the Lungs; A Study of the Patterns of the Segmental Bronchi and Related Pulmonary Vessels. By Edward A. Boyden, Ph.D. (Med.Sc.), Professor Emeritus of Anatomy, The Medical School, University of Minnesota. Cloth. Price, $15.00. Pp. 276, with numerous illustrations. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, New York, 1955.

The Spine; A Radiological Text and Atlas. By Bernard S. Epstein, M.D., Chief, Department of Radiology, The Long Island Jewish Hospital, New Hyde Park, New York. Cloth. Price, $16.50. Pp. 539, with 331 illustrations. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1955.

Small-Angle Scattering of X-Rays. By André Guinier, Professor, Université de Paris (France), and Gérard Fournet, Lecturer, École Supérieure de Physique et Chimie, Paris. Translation by Christopher B. Walker, Institute for the Study of Metals, University of Chicago. Cloth. Price,

$7.50. Pp. 268, with 78 illustrations. John Wiley & Sons, Inc. 440 Fourth Avenue, New York 16, New York, 1955.

Röntgendiagnostik des Schädels. By Prof. Dr. Willy Loepp, weil.a.o. Prof. für Röntgenologie an der Universität Königsberg (Pr.); and Prof. Dr. Reinhold Lorenz, a.pl. Prof. an der Universität Hamburg, Chefarzt des Röntgenistituts des Krankenhauses, Hamburg-Barmbeck. Cloth. Price, DM 97.—. Pp. 579, with 613 illustrations. Georg Thieme Verlag, Herdweg 63, Stuttgart, Germany, 1954.

The Blood-Brain Barrier, By Louis Bakay, M.D., F.A.C.S., Instructor in Surgery, Harvard Medical School; Assistant in Neurosurgery, Massachusetts General Hospital, Boston, Massachusetts. Cloth. Price, $5.50. Pp. 154, with 32 illustrations and 10 tables. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1956.

Curso Extraordinario de Cancerología para Graduados. By Dr. Abel N. Canonico, Profesor Titular de Clinica Quirúrgica, Director del Instituto de Medicina Experimental, Universidad de Buenos Aires. Paper. Pp. 340, with tables. Universidad de Buenos Aires, Buenos Aires, Argentina, 1954.

Gastroileostomia Inadvertida. By Mario Ramos de Oliveira, M.D., F.A.C.S. Apresentada à Factuldade de Medicina da Universidade de São Paulo. Paper. Pp. 229, with illustrations and tables. Mario Ramos de Oliveira, Rua 7 de Abril, 118 6.° And. Sala 602, São Paulo, Brazil, 1953.

Trabajos de Oncología y Radioterapia, Años 1953–1954. Publicaciones del Instituto de Radiología y Ciencias Físicas Bajo la Direccíon del Prof. Alfonso C. Frangella, Director Interino del Instituto, Prof. Honorario F. de Medicina Universidad Nal. de Colombia. Paper. Pp. 525, with tables and illustrations. "Rosgal," Montevideo, Uruguay, 1955.

Nuclear and Radiochemistry; Revised Version of Introduction to Radiochemistry. By Gerhart Friedlander, Senior Chemist, Brookhaven National Laboratory; and Joseph W. Kennedy, Professor of Chemistry, Washington University, St. Louis. Cloth. Price, $7.50. Pp. 468, with 13 illustrations. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, 1955.

Joint Ligament Relaxation Treated by Fibro-Osseous Proliferation. By George Stuart Hackett, M.D., F.A.C.S., Consulting Surgeon, Mercy Hospital, Canton, Ohio. Cloth. Price, $4.75. Pp. 97, with 17 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1956.

Medical Photography; Radiographic and Clinical. By T. A. Longmore, Hon. F.S.R., Principal, Kodak School of Medical Radiography and Clinical Photography; Hon. Editor of "Radiography," Member of Council, Education Committee and Board of Examiners of the Society of Radiographers; Late Senior Instructor in Radiographic and Medical Photography at the Royal Army Medical College, etc. Fifth edition. Cloth. Price, $15.00. Pp. 1000, with 319 figures and 76 plates. Focal Press Ltd., 31 Fitzroy Square, London W.1, England, 1955.

Elementos de Medicina Infantil. By Carlos M. Monsón Malice, Catedrático Auxiliar de Pediatría y de Terapéutica Clínica en la Facultad de Ciencias Médicas. Paper. Seven parts, individually paged, with illustrations. Editorial Universitaria, Universidad de San Carlos de Guatemala, Guatemala, C. A., 1951.

Pelvo-Spondylitis Ossificans; Rheumatoid or Ankylosing Spondylitis. By Ragnar Romanus, M.D., and Sven Ydén, M.D., Karolinska Sjukhuset and King Gustaf V's Research Institute, Stockholm, Sweden. Cloth. Price, $8.50. Pp. 162, with 55 illustrations. Year Book Publishers, Inc., 200 E. Illinois Street, Chicago 11, Illinois, 1955.

Bone and Joint X-Ray Diagnosis. By Max Ritvo, M.D., Assistant Clinical Professor of Radiology, Harvard Medical School; Instructor in Radiology, Tufts College Medical School; Lecturer on Radiology, Boston University School of Medicine; Director, Department of Radiology and Roentgenologist-in-Chief, Boston City Hospital. Cloth. Price, $20.00. Pp. 752, with 398 illustrations. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1955.

Chest X-Ray Diagnosis. By Max Ritvo, M.D., Assistant Clinical Professor of Radiology, Harvard Medical School; Instructor in Radiology, Tufts Medical School; Lecturer on Radiology, Boston University School of Medicine; Roentgenologist-in-Chief and Director, Department of Radiology, Boston City Hospital. Second edition. Cloth. Price, $16.00. Pp. 640, with 426 illustrations. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1956.

Nuclear Radiation Detectors. By J. Sharpe, B.Sc., A.M.I.E.E., Late of Atomic Energy Research Establishment, Harwell. Cloth. Price, $2.50. Pp. 184, with tables and illustrations. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, 1955.

The Biliary Tract. By Julian A. Sterling, A.B., M.D., M.Med.Sc., Sc.D., F.A.C.S., Staff Surgeon, Albert Einstein Medical Center and the Graduate Hospital; Chief Surgeon, Psychiatric Hospital;

Associate in Surgery, Graduate School of Medicine, University of Pennsylvania, Philadelphia. Cloth. Price, $10.00. Pp. 424, with 94 illustrations. The Williams & Wilkins Company, Mt. Royal and Guilford Avenues, Baltimore 2, Maryland, 1955.

CARDIAC DIAGNOSIS; A PHYSIOLOGIC APPROACH. By Robert F. Rushmer, M.D., Associate Professor of Physiology and Biophysics, University of Washington Medical School. Cloth. Price, $11.50. Pp. 447, with numerous illustrations. W. B. Saunders Company, 218 W. Washington Square, Philadelphia 5, Pennsylvania, 1955.

ANNUAL REVIEW OF MEDICINE. VOLUME 6. 1955. David A. Rytand, Editor. Cloth. Price, $7.00. Pp. 459, with tables. Annual Reviews, Inc., Stanford, California, 1955.

CLINICAL APPROACH TO JAUNDICE. By Leon Schiff, M.D., Ph.D., Professor of Clinical Medicine, Department of Internal Medicine, University of Cincinnati College of Medicine; Director, Gastric Laboratory, Cincinnati General Hospital. Cloth. Price, $3.75. Pp. 113, with 52 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1954.

SURGICAL FORUM; PROCEEDINGS OF THE FORUM SESSIONS, FORTIETH CLINICAL CONGRESS OF THE AMERICAN COLLEGE OF SURGEONS, ATLANTIC CITY, N. J., NOVEMBER, 1954. By Committee on Forum on Fundamental Surgical Problems, Harris B. Shumacker, Jr., M.D., F.A.C.S., Indianapolis, Chairman. Cloth. Price, $10.00. Pp. 851, with numerous illustrations. W. B. Saunders Company, 218 W. Washington Square, Philadelphia, Pennsylvania, 1955.

ELECTROCHEMISTRY IN BIOLOGY AND MEDICINE. Edited by Theodore Shedlovsky, Rockefeller Institute for Medical Research. Cloth. Price, $10.50. Pp. 369, with numerous illustrations. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, 1955.

LEHRBUCH DER RÖNTGENOLOGISCHEN DIFFERENTIALDIAGNOSTIK. By Werner Teschendorf, Köln. Volume II. Third edition. Cloth. Price, DM 186.—. Pp. 1037, with 1610 illustrations. Georg Thieme Verlag, Herdweg 63, Stuttgart, Germany, 1954.

SURGERY OF THE ELBOW. By Frederick M. Smith, M.D., Associate Professor of Clinical Orthopedic Surgery, Columbia University, New York City. Cloth. Price, $10.75. Pp. 340, with 153 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1954.

PATHOLOGIC PHYSIOLOGY; MECHANISMS OF DISEASE. Edited by William A. Sodeman, M.D., F.A.C.P., Professor of Medicine and Chairman of the Department of Medicine, School of Medicine, University of Missouri, Columbia, Missouri. Second edition. Cloth. Price, $13.00. Pp. 963, with 173 illustrations. W. B. Saunders Company, 218 W. Washington Square, Philadelphia 5, Pennsylvania, 1956.

HEMATOLOGY. By Cyrus C. Sturgis, M.D., Professor of Internal Medicine, Chairman of the Department of Internal Medicine, University of Michigan Medical School, and Director of the Thomas Henry Simpson Memorial Institute for Medical Research, University of Michigan, Ann Arbor, Michigan. Second edition. Cloth. Price, $19.50. Pp. 1222, with 79 illustrations and 44 tables. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1955.

THE THYROID. Sidney C. Werner, M.D., Sc.D. (Med.), Editor. Cloth. Price, $20.00. Pp. 789, with 130 illustrations and 65 tables. Paul B. Hoeber, Inc., 49 East 33rd Street, New York 16, New York, 1955.

Vol. 75, No. 5

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

Bebin, J., and Tytus, J. S.: Ossification in gliomas 1016
Lofstrom, J. E., Webster, J. E., and Gurdjian, E. S.: Angiography in the evaluation of intracranial trauma 1016
Maslowski, H. A.: Vertebral angiography: percutaneous lateral atlanto-occipital method. 1016

Neck and Chest

Groves, L. K., and Effler, D. B.: Broncholithiasis; a review of twenty-seven cases 1017
Bumgarner, J. R., Gahwyler, M., and Ward, D. E.: Persistent fibrin bodies presenting as coin lesions 1017
Zizmor, J.: Bronchography in diagnosis of bronchogenic carcinoma in two patients with apparently normal chest films 1018
Nordenström, B.: Bronchography by the aspiration of contrast media 1018
Donnell, J. J., Levinson, D. C., and Griffith, G. C.: Clinical studies on involvement of the pulmonary artery by syphilitic aortic aneurysms 1018
Fleischner, F. G., and Sagall, E. L.: Pulmonary arterial oligemia in mitral stenosis as revealed on the plain roentgenogram 1019
Arvidsson, H., Karnell, J., and Möller, T.: Multiple stenosis of the pulmonary arteries associated with pulmonary hypertension, diagnosed by selective angiocardiography .. 1019
Philipson, J., and Saltzman, G.-F.: Combined ventricular septal defect and aortic insufficiency 1020

Abdomen

Astley, R.: Oesophageal "spasm" in infancy .. 1020
Palmer, E. D.: Saint's triad (hiatus hernia, gall stones and diverticulosis coli): the problem of properly directing surgical therapy. . 1021
Beranbaum, S. L., and Subbarao, K.: The hypertrophied ileo-cecal valve 1021
Beranbaum, S. L., and Subbarao, K.: The ileo-cecal valve in diseases 1021
Lumb, G., Proteroe, H. B., and Ramsay, G. S.: Ulcerative colitis with dilatation of the colon 1022
Busson, A., and Morin, G.: Acute diverticulitis of the sigmoid and left colon 1022
Strelinger, A.: Biliary dyssynergia: report of two cases 1022
Batt, R. C.: Intravenous cholecystangiography 1022

Gynecology and Obstetrics

Granjon, A., Philippe, D., and Beau, A.-M.: Lengthening and hypertrophy of the cervix. 1023

Genitourinary System

Pyrah, L. N., and Raper, F. P.: Renal calcification and calculus formation 1023
Stewart, H. H.: Calcification and calculus formation in the upper urinary tract 1023
Hellström, J.: Calcification and calculus formation in a series of seventy cases of primary hyperparathyroidism 1024
Kobayashi, O., and Sakaguchi, S.: Unilateral renal hypertension in a girl cured by nephrectomy 1024
Kalmon, E. H., Albers, D. D., and Dunn, J. H.: Ureteral jet phenomenon; stream of opaque medium simulating an anomalous configuration of the ureter 1024
Brunschwig, A., and Daniel, W.: Observations on the urinary tract four to seven years after total pelvic exenteration and wet colostomy 1025

Nervous System

Chavany, J. A., Carrère, J. P., and Pochard, M.: A type of post-traumatic encephalopathy of subacute development with blindness and severe, irreversible psychic disturbances 1025
Bell, R. L.: Hemangioma of a dorsal vertebra with collapse and compression myelopathy. 1025
Reinhardt, K.: Problems encountered in examination of the spinal canal with contrast media 1025

Skeletal System

Bjornson, R. G. B.: Developmental anomaly of the lateral malleolus simulating fracture .. 1026
Ponseti, I. V., and McClintock, R.: The pathology of slipping of the upper femoral epiphysis 1026

ROENTGEN DIAGNOSIS

Head

Bebin, J., and Tytus, J. S. Ossification in gliomas. *J. Neurosurg.*, Nov., 1955, *12*, 577–583. (From: Laboratory of Neuropathology, Neuropsychiatric Institute, and Department of Surgery, Section of Neurosurgery, University Hospital, University of Michigan, Ann Arbor, Mich.)

A review of the literature revealed that in a study of 1,577 intracranial tumors microscopic calcification was found in 13 per cent and roentgenographic calcification in 7 per cent. In 131 cases of cerebellar astrocytomas calcification was found roentgenologically in 8.5 per cent and microscopically in 16.3 per cent. In 200 cases of oligodendroglioma calcium deposits were found microscopically in 70 per cent and roentgenologically in 38 per cent. This review of the literature revealed no report of ossification except for a case of mixed ependymoblastoma and osteoblastoma reported by Mackay.

The authors present two case reports of gliomas, each of which showed ossification within the tumor. One was an astrocytoma of the cerebellum of 25 years' duration, the other was an oligodendroglioma of 9 years' duration.—*John F. Weigen, M.D.*

Lofstrom, J. E., Webster, J. E., and Gurdjian, E. S. Angiography in the evaluation of intracranial trauma. *Radiology*, Dec., 1955, *65*, 847–856. (From: Departments of Radiology and Neurosurgery, Wayne University College of Medicine Affiliated Hospitals, Detroit Receiving Hospital, Detroit Memorial Hospital, and Grace Hospital, Detroit, Mich.)

Carotid arteriography has been used for many years as an aid in the diagnosis of intracranial lesions. In an attempt to reduce the diagnostic error in patients with an intracranial mass occurring as a result of trauma this procedure has been used in approximately 500 instances and has proved a valuable clinical aid to early and accurate diagnosis.

Studies were carried out first on cadaver material. Intracranial epidural masses were produced by injecting a lipid material in various amounts and locations and then roentgenograms made after opacification of the carotid artery systems were studied. A remarkable similarity in vascular pattern was found to exist between these artificially produced mass lesions and those encountered following cranial trauma.

A mass in the temporal area will produce a separation of the branches of the middle cerebral artery from the inner table of the skull. Larger masses also elevate the middle cerebral group. Little or no shift of the anterior cerebral artery is seen. Small frontal masses will cause a bowing of the anterior cerebral artery and a beginning depression of the terminal branches of the middle cerebral artery seen best in the Towne projection. Larger masses in this region can be seen in the lateral view.

Anterior and posterior parietal region masses show a characteristic shift of the middle cerebral branches away from the inner table of the skull. The anterior cerebral group will be shifted when larger masses are present, and more so when located in the anterior parietal region. A mass situated over the occipital lobe will show flattening of the peripheral branches of the middle cerebral artery and finally displacement inferiorly from the inner table. The absence of shift of the anterior cerebral artery across the midline in the Towne projection will differentiate these findings from those produced by a frontal mass.

Posterior fossa masses cannot be detected by either vertebral or internal carotid angiography.

This procedure has been found very useful in patients in whom a history or clinical evidence of cranial trauma cannot be obtained. The diagnosis or exclusion of a surgical lesion is possible without exploratory operation when trauma may be incidental to alcoholism, a cerebral vascular accident or conditions involving stupor or coma. Early diagnosis, lateralization and localization of intracranial hematomata is permitted by this roentgenographic examination which susbtitutes for an exploratory trephine operation.—*Donald N. Dysart, M.D.*

Maslowski, Henry A. (Manchester, England.) Vertebral angiography: Percutaneous lateral atlanto-occipital method. *Brit. J. Surg.*, July, 1955, *43*, 1–8.

Although information about the vertebral arterial system is just as interesting as that obtained from the carotid system, vertebral angiography has lagged behind carotid angiography, because of technical difficulties. The author describes a method of percutaneous vertebral angiography which he believes can be applied with almost the same facility as carotid angiography. The vertebral artery is punctured as it winds around the lateral mass of the atlas, the artery being approached laterally in the plane of the tip of the mastoid process. The anatomic aspects of the region and the safety of the method are discussed. The procedure is done while the patient is under the influence of general anesthesia.

Since 1950, when the method was evolved, it has been used in 104 cases, and in only 11 cases was it impossible to secure angiograms. The average time required for satisfactory placement of the needle was thirteen and one-half minutes.

The complications encountered were not dependent on the method, but are inherent in vertebral angiography. One death occurred in this group, and necropsy revealed it to have been caused by thrombosis of the left vertebral artery, extending from

just proximal to the origin of the postero-inferior cerebellar artery to the proximal 2 cm. of the basilar artery. Other complications included temporary (a few months') hemiplegia, temporary nystagmus, vomiting and retarded recovery of consciousness after anesthesia, transient pupillary changes and unilateral muscular hypotonia from which recovery was made in 2 hours, and undue somnolence from which recovery was made within a day or so.

Several other methods for the performance of vertebral angiography are reviewed. Judging by results and facility of performance, the lateral atlanto-occipital method does not appear to be inferior to any of the others.

"Probably the greatest obstacle to acceptance and employment of the method is a psychologic factor." The great advantage of this method is that, because of the direction in which the needle enters the artery, the needle becomes more securely placed in the vessel than is true when other percutaneous methods are used. The method is comfortable to the patient, with little postoperative discomfort. The author feels that, even though his method may not be found suitable by all who try it, there are now two or three reasonably successful methods at hand, and that failure to achieve satisfactory vertebral angiograms should be rare.—*André J. Bruwer, M.D.*

Neck and Chest

Groves, Laurence K., and Effler, Donald B. Broncholithiasis; a review of twenty-seven cases. *Am. Rev. Tuberc. & Pulmonary Dis.*, Jan., 1956, *73*, 19–30. (From: Department of Thoracic Surgery, The Cleveland Clinic Foundation, and The Frank E. Bunts Educational Institute, Cleveland, Ohio.)

This article is a report of 27 patients with the clinical and operative manifestations of broncholithiasis.

Calcifications related to the tracheobronchial tree represent the end-stages of many types of lymphadenitis. At the time the calcification has occurred, identifying histologic or bacteriologic features are usually absent. Histoplasmosis and other fungal diseases, tuberculosis, chronic pulmonary suppuration, and anthracosis appear to be the etiologic factors most often encountered. Actually the etiology of broncholithiasis is rarely important since the calcific residuum forms the mechanical basis for a new and unrelated disease process.

In the 27 cases reported, broncholithiasis was manifested by hemoptosis (in 17 patients), cough (in 16 patients), fever (in 6 patients), wheezing (in 6 patients), dyspnea (in 3 patients), chest pain (in 2 patients), coughed "stones" (in 2 patients) and weight loss (in 2 patients). Hemoptysis and harassing cough were usually the initial symptoms. A peripheral calcification situated beyond the cough reflex area or too distal to cause obstructive pneumonitis may be evidenced by hemoptysis only. Similarly, calcifications may erode adjacent blood vessels to produce hemoptysis without cough. Small calcifications may be totally extruded by coughing whereas the more sessile broncholiths produce varying degrees of bronchial obstruction resulting in obstructive pneumonitis, bronchiectasis, or emphysema. Chronic active pulmonary suppuration and fibrotic contraction of pulmonary parenchyma distal to the lesion may be attended by symptoms of fever, wheezing, dyspnea, and chest pain.

Bronchogenic carcinoma or other obstructing bronchial lesions and tuberculosis are the most important considerations in the differential diagnosis. Calcifications demonstrated roentgenographically are of little diagnostic value since the incidence of calcification is reported to be 50 per cent in otherwise normal individuals taken at random. The use of laminagrams may increase the accuracy of roentgen diagnosis. In the 27 cases reported, prominent calcifications and features of pneumonitis were the most common roentgenographic manifestations. Broncholithiasis *per se* was suggested in only two patients on the basis of the roentgen examination.

The treatment is primarily surgical and depends largely upon the situation of the broncholith. The most common situation is a broncholith destroying bronchial integrity by erosion with associated obstructive pneumonitis. The treatment requires resection of the involved portion of the bronchial tree. Segmental resections are rarely suitable in this disease since the most common site for bronchial erosion is at the level of the lobar bronchi. Paratracheal or subcarinal erosions have not been adequately treated in the past but a more vigorous surgical treatment is contemplated for the future.

The authors invite an awareness of broncholithiasis so that applicable diagnostic procedures (bronchoscopy, laminagraphy) will be more frequently employed and an earlier diagnosis may be made. An aggressive therapeutic approach gives the best results in the earlier phases of the disease.—*J. W. Wilson, M.D.*

Bumgarner, John R., Gahwyler, Max, and Ward, D. E. Persistent fibrin bodies presenting as coin lesions. *Am. Rev. Tuber. & Pulmonary Dis.*, Nov., 1955, *72*, 659–662. (From: Western North Carolina Sanatorium, Black Mountain, North Carolina.)

The authors present a case wherein a fibrin body developed over a period of years and which after development could easily be mistaken for a coin lesion. The factors in development of a fibrin body are given; namely, effusion present for a prolonged period and usually pneumothorax.

The case is that of a tuberculous patient followed over a period of fourteen years. The fibrin body was

present for the last nine years. It is recommended that fibrin bodies be considered in the differentiation of coin lesions particularly if there is a history of pleural effusion.—*P. B. Parsons, M.D.*

Zizmor, Judah. Bronchography in diagnosis of bronchogenic carcinoma in two patients with apparently normal chest films. *Radiology*, Dec., 1955, *65*, 868–874. (Address: 136 East 64th St., New York 21, N. Y.)

Bronchography can be a definite aid in the diagnosis of bronchogenic carcinoma. In involvement of one of the larger bronchi, narrowing and infiltration is seen, with partial or complete obstruction present. In alveolar cell carcinoma, bronchography will show a uniform diffuse narrowing of segmental bronchi, with bronchial rigidity and elongation in the involved region. Filling rather than coating of these lumina occurs, with a lack of filling distally of the terminal bronchioles and alveoli. Even when the diagnosis has been made by other means, bronchography can localize the exact point of bronchial obstruction. One must remember the other causes of bronchostenosis or obstruction, such as benign bronchial tumor, foreign bodies, mucous plugs, bronchiectasis, tuberculosis, hydatid cysts, and bronchial agenesis.

Bronchogenic carcinoma almost always produces significant changes that can be seen on a conventional chest film. Any of the following may be present: obstructive emphysema, unresolving pneumonia, segmental or lobar atelectasis, lymphangitic infiltrates, tumor nodule, thick-walled abscesses, hilar or mediastinal masses, or pleural effusion.

In early carcinoma of the larger bronchi, the chest film may appear normal, even though the patient is already symptomatic. This has been previously discussed by Ochsner, Overholt, Robbins, Steinberg and Dotter, Rabin, and Rigler. Rigler has suggested that minimal changes are overlooked in these cases. Evaluation of such findings as slight unilateral hilar enlargement, minor degrees of obstructive emphysema, linear atelectasis of a small lung segment, and small infiltrates are difficult, since they are so often seen in older patients without carcinoma. However, when the symptoms of cough, wheezing, expectoration, or hemoptysis are present, these changes should alert the radiologist, and even when the conventional chest film is normal, a thorough roentgenologic study and other investigations should be made.—*C. L. Stevenson, M.D.*

Nordenström, Björn. Bronchography by the aspiration of contrast media. *Acta radiol.*, Oct., 1955, *44*, 281–288. (From: Roentgen Department, Sabbatsbergs Sjukhus, Stockholm, Sweden.)

The author discusses the importance of a complete bronchographic exploration of the bronchial tree, particularly in the case of bronchiectasis where there are diffuse changes, the extent of which cannot be determined by other means. In operative treatment for bronchiectasis if the examination is incomplete the patient may not be radically cured in spite of surgical intervention.

In the technique described by the author anesthesia is achieved by premedication with 0.1 g. of barbiturate and 0.4 to 0.8 ml. of Scophedal (Merck) for an adult; the pharynx is anesthetized with 2 per cent tetracaine, and the trachea and bronchial tree with 3 to 6 ml. of tetracaine instilled between the vocal cords. Following this a radiopaque plastic catheter is introduced until its tip is a few centimeters distal to the carina in the main bronchus of the lung to be examined. The catheter employed may be set in any desired shape during the process of sterilization.

Dionosil (Glaxo, oily or water-soluble) is used as the contrast medium. The amount employed is usually between 10 and 20 ml. depending on the size of the patient. The patient is placed in a true lateral position, lying on the side to be examined; he is told to take one or two breaths, and then to hold his breath in expiration. The contrast medium is quickly injected into the main bronchus under fluoroscopic control. Immediately on conclusion of the injection, the patient is asked to take a deep breath so as to aspirate the contrast medium, which usually is rapidly distributed peripherally throughout the bronchial tree. Roentgenograms are obtained under fluoroscopic control with the patient in the upright position.

When it is doubtful whether unsatisfactory filling of a region is caused by pathologic change in a bronchus or by the accumulation of secretion in a normal bronchus, the examination must be supplemented by selective contrast filling.

In the opinion of the author, when the contrast medium is aspirated, the risk of extensive effusion into the parenchyma of the lung is considerably less than when it is injected directly into the lobar or segmental bronchi. Also the contrast medium forms a film on the surface of the bronchial walls instead of massively blocking the lumina. This produces 'double contrast' roentgenograms, and also utilizes the volume of contrast medium to its best advantage. —*Wallace M. Roy, M.D.*

Donnell, John J., Levinson, David C., and Griffith, George C. Clinical studies on involvement of the pulmonary artery by syphilitic aortic aneurysms. *Circulation*, Jan., 1956, *13*, 75–81. (From: University of Southern California School of Medicine, Department of Medicine (Cardiology), and Los Angeles County Hospital, Los Angeles, Calif.)

Two cases of luetic aortic aneurysms encroaching upon the pulmonary artery circulation are reported.

In the first case, the aneurysm obstructed the pulmonary artery by extrinsic pressure and created chronic cor pulmonale. This occurred in a 30-year old man who had the signs and symptoms of an aortic aneurysm that was shown roentgenographically. However, the electrocardiogram showed right axis deviation. As a result cardiac catheterization was performed which demonstrated moderate right ventricular hypertension, hypertension in the main pulmonary artery, and an abrupt rise in pressure as the catheter was withdrawn from the right pulmonary artery toward the main pulmonary artery. This pressure gradient could be repeatedly demonstrated upon withdrawal and re-insertion of the catheter into the right pulmonary artery. Angiocardiography demonstrated normal filling of the left pulmonary artery but nonvisualization of the right pulmonary artery indicating obstruction by the large aortic aneurysm.

In the second case, the aneurysm ruptured directly into the pulmonary artery producing a chronic aortic-pulmonary fistula. Usually the establishment of an aortic-pulmonary fistula by rupture of an aneurysm is ushered in clinically by an acute and disastrous event; but if the patient survives, the fistula essentially establishes the analogue of a patent ductus arteriosus. In this case, a 46-year old woman, whose roentgenograms demonstrated left ventricular enlargement and an aneurysm of aortic arch, also had a continuous murmur with systolic accentuation best heard in the fourth left intercostal space next to the sternum. On the basis of this, cardiac catheterization was performed which showed (1) definite evidence of left to right shunt in the pulmonary artery and (2) elevation of pressure in the right ventricle, pulmonary artery, and wedged peripheral pulmonary artery probably secondary to left ventricular failure. At angiocardiography, the radiopaque material failed to opacify the left pulmonary artery indicating the encroachment by the aortic aneurysm. Exploratory thoracotomy corroborated the presence of an aortic aneurysm with fistulous communication existing between the left pulmonary artery.

In any patient with an aortic aneurysm and aortic insufficiency, the clue to pulmonary artery involvement is found in the electrocardiogram which shows right axis deviation. The signs and symptoms suggesting patent ductus arteriosus in the presence of an aortic aneurysm should make one consider rupture into the pulmonary artery. However, dissection and rupture of an aneurysm into the heart chambers or other great vessels may produce a similar murmur and thrill. When any of these complications are suspected, cardiac catheterization and angiocardiography are suited studies for eliciting the true diagnosis. —*John W. Wilson, M.D.*

Fleischner, Felix G., and Sagall, Elliot L. Pulmonary arterial oligemia in mitral stenosis as revealed on the plain roentgenogram. *Radiology*, Dec., 1955, *65*, 857–867. (From: Departments of Radiology and Medicine of Beth Israel Hospital and Harvard Medical School, Boston, Mass.)

The authors reviewed the plain roentgenograms of subjects with mitral stenosis and correlated the findings with the clinical course. The clinical grading used was that of the New York Heart Association: Class I, no limitation of physical activity. Class II, slight limitation and dyspnea on severe exertion. Class III, marked limitation even with moderate physical activity. Class IV, inability to carry on any physical activity without discomfort.

Patients in Group I ordinarily show no abnormal vascular pattern. In Group II, one usually observes moderate to marked dilatation of the arterial hilar shadows and proportionate dilatation of the arterial branches forming the tail of the right hilar shadow. The pulmonary veins, if distinguishable, are wider than normal. There is faint general haziness, particularly in the lower lung fields, and often a delicate reticular pattern.

In Groups III and IV, marked elevation of the pulmonary arterial pressure, right ventricular hypertrophy, dilatation, and eventually right-side failure occur. The hilar shadows are large and bulging. Large vessels converge toward the upper poles of the right and left hilar shadows. The lateral and lower contour of the right hilar shadows stand out distinctly because of the absence of vascular branches. The tail of the right hilar shadow is absent. Only narrow, tortuous vascular shadows are visible in place of the normal branches. The entire lung fields show diminished translucency. Finely spotted densities may be present, apparently the result of extravasated fluid, hemosiderin deposits or fibrosis.

Arterial oligemia of the lung is the roentgenologic manifestation of constriction of the medium-sized arteries and appears to be reversible for a certain period of time. It signalizes a turn in the development of the circulatory disorders, usually in the direction of deterioration. Recognition of this arterial change may be a valuable aid in determining the need for surgical intervention.—*Arno W. Sommer, M.D.*

Arvidsson, H., Karnell, J., and Möller, T. Multiple stenosis of the pulmonary arteries associated with pulmonary hypertension, diagnosed by selective angiocardiography. *Acta radiol.*, Sept., 1955, *44*, 209–216. (From: Roentgen Department I, and Medical Clinic II, Södersjukhuset, and the Pediatric Clinic, Kronprinsessan Lovisas Barnsjukhus, Stockholm, Sweden.)

The causes of pulmonary hypertension are classified as follows.

1. Increased flow of blood through the lungs, as found in conditions with left-to-right shunts; and

2. Increased resistance in the lungs, meaning (*a*) chronic disease of the lungs, (*b*) left heart failure, with stasis, such as mitral disease, (*c*) increased resistance in pulmonary arterioles, (*d*) chronic pulmonary embolism with obliteration of smaller or larger pulmonary arteries, or both.

This paper deals primarily with the demonstration of a hitherto undescribed cause of pulmonary hypertension. In four patients the cause for the pulmonary hypertension was the presence of multiple stenoses of the peripheral arteries of the lungs, probably on a congenital basis.

In one patient, a 13-year-old girl, a continuous murmur was present over the entire precordium. This led to the suspicion of patent ductus arteriosus, but cardiac catheterization, angiocardiography via the superior vena cava and retrograde aortography did not demonstrate any evidence of it. Because of the method of angiocardiography used, the stenotic areas in the pulmonary lobar arteries were not visualized. Two years later selective angiocardiography, with the catheter in the pulmonary trunk, resulted in remarkably clear demonstration of marked strictures of the lobar pulmonary arteries.

In the second patient, a girl of 19 years, selective angiocardiography showed that only the upper parts of the lungs received vessels from the pulmonary artery. The right upper pulmonary artery divided into an upper and a lower branch, the latter terminating in a blind pouch about 3 cm. beyond the bifurcation. The branches of the artery to the right upper lobe were wide and irregular, and one was markedly stenosed and showed poststenotic dilatation. The lingula and the middle and both lower lobes did not appear to have any supply from the pulmonary arteries, but these areas did have a supply from the bronchial arteries.

Two other somewhat similar cases also are described.—*André J. Bruwer, M.D.*

Philipson, Jan, and Saltzman, Georg-Fredrik. Combined ventricular septal defect and aortic insufficiency. *Acta radiol.*, Oct., 1955, *44*, 269–280. (From: Heart Clinic and Roentgen Department I, Södersjukhuset, Stockholm, Sweden.)

Catheterization and opacification of the heart chambers and great vessels enhance the possibility of making a correct diagnosis even in cases of complicated congenital malformations. These examinations should be performed when the diagnosis can not be made by other means. The authors consider the application of this method of diagnosis in cases of combined ventricular septal defect and aortic insufficiency and their differential diagnosis from patent ductus arteriosus.

In the cases reported in this article the diagnosis of congenital cardiac defect was established early in infancy, but differential diagnosis was not made at the time. All patients were males, acyanotic, and presented a systodiastolic murmur with maximum intensity at the third to fourth interspace to the left of the sternum and a strong palpable thrill. The pulse pressure was raised. Cardiac catheterization was done through a cubital vein; oxygen saturation and blood pressure determinations were carefully carried out. A left to right shunt was established in each case. The catheter could not be passed through the septal defect.

Roentgenologic findings: Conventional roentgenograms revealed marked rather uniform cardiac enlargement. In some cases the left ventricular enlargement was pronounced. The pulmonary artery and its branches were moderately dilated. During fluoroscopy, increased pulsations of the heart and great vessels were noted and the aorta was generally of normal caliber. Thus the conventional roentgen examination alone afforded valuable information of diagnostic significance.

Differential diagnosis includes patent ductus arteriosus and less frequently aortic septal defect and ruptured aneurysm of the aortic sinus. In the latter, the course is very dramatic and death occurs soon after, so that no real problem of differential diagnosis occurs.

Characteristic cases of patent ductus arteriosus present a continuous murmur which is heard one to two intercostal spaces above the level of the murmur encountered in ventricular septal defect. There is also marked cardiac enlargement. The pulmonary artery is dilated and the aorta is likewise dilated. The authors caution that the greatly enlarged hearts, as seen in the above conditions, are extremely sensitive to pressure lowering measures which are utilized in connection with such an examination. There is a special warning against the use of pentothal and similar anesthetics.

The authors present a short survey of the literature as well as the clinical data and roentgenologic findings in 4 cases of combined ventricular septal defect and aortic insufficiency and in 2 hemodynamically similar cases.

Reproductions of roentgenograms of eight cases and two tables accompany this article.—*William H. Shehadi, M.D.*

Abdomen

Astley, Roy. Oesophageal "spasm" in infancy. *Proc. Roy. Soc. Med.*, Dec., 1955, *12*, 1045–1049. (From: The Children's Hospital, Birmingham, England.)

The author reports 4 cases of temporary esophageal spasm in infants, and 3 were associated with hiatus hernia (and presumably esophagitis). No cause could be found in one case but the spasm disappeared after dilatation with a catheter and the esophagus subsequently became normal.

The last case is that of a one-year old who had a

foregut duplication cyst removed. One week later, the esophagus had changed from a previously normal to a dilated, elongated, tortuous tube with quite active peristalsis but delayed passage of barium.

The appearance suggested that seen in adult cardiospasm. On subsequent studies, it became more normal. The explanation for this postoperative change is not certain but is thought to be due to the disturbance of the vagus nerve at the time of surgery.—*George L. Sackett, Jr., M.D.*

PALMER, EDDY D. Saint's triad (hiatus hernia, gall stones and diverticulosis coli): The problem of properly directing surgical therapy. *Am. J. Digest, Dis.*, Nov., 1955, *22*, 314–315. (From: Gastroenterology Service, Walter Reed Army Hospital, Washington, D. C.)

A striking example of multiple coexisting surgical diseases is Saint's triad—hiatus hernia, cholelithiasis, and diverticulosis of the colon, named after Professor Saint of Cape Town, South Africa, who stressed this association.

Routine and clinical investigation of 170 adult patients with hiatus hernia demonstrated the presence of cholelithiasis and diverticulosis of the colon in 24 patients, or 14 per cent.

In 6 patients all three lesions were detected during the course of a single diagnostic investigation. In another 6 patients all three lesions became apparent within two years following the onset of abdominal symptoms, while it took more than two years for the triad to develop in the remaining patients.

Based on the author's observation and a review of the literature, it is suggested that when a patient with hiatus hernia is found to have either diverticulosis or cholelithiasis there is good chance of his having the third condition.—*William H. Shehadi, M.D.*

BERANBAUM, S. L., and SUBBARAO, KAKARLA. The hypertrophied ileo-cecal valve. *Am. J. Digest. Dis.*, Nov., 1955, *22*, 307–313. (From: University Hospital, New York University, Bellevue Medical Center, New York, N. Y.)

Guided by their own modification of Hinkel's classification, the authors use the following as a basis for evaluation of their studies and for the differential diagnosis between benign and malignant lesions of the ileocecal valve.

I. Unusually conspicuous ileocecal valve of normal size.
   a. Unusual sites of insertion (posterior, lateral and high).
   b. Common ileocecal wall.
   c. Distortion due to adhesions and congenital membranes.
II. Unusually large ileocecal valve.
   a. Edema
   b. Hypertrophy
   c. Fatty infiltration
   d. Tumor
III. Invagination or prolapse of the terminal ileum through the valve.
IV. Combination of the above.

Malignant tumors of the ileocecal valve are rare; when present, there is an irregular asymmetrical defect with destruction of the mucosa. In benign hypertrophy the defect is smooth with symmetrical enlargement of both the upper and lower lips. The mucosa is intact and a stellate or slit-like pattern may be observed, a definite sign of benignity. Defects in the cecum and ascending colon have to be considered in differential diagnosis. They are easy to identify.

Each normal lip of the ileocecal valve measures 3–5 mm. Measurements of 6 mm. or more, indicate enlargement. The authors emphasize the importance of double contrast studies and of evaluating the terminal ileum through reflux of barium. Should this not occur during the barium enema study, then the ileocecal valve should be carefully studied following oral administration of a barium meal.

Ileal prolapse, previously considered rare, may be encountered not infrequently with careful studies of the ileocecal area. This may be difficult to differentiate from hypertrophy. Multiple compression spot films help greatly in the differential diagnosis. Hypertrophied ileocecal valve produces a concentric defect while a greater variability in appearance is noted in prolapse. In the latter condition the invaginated ileal mucosa is more wrinkled and puckered than the mucosa of the colon. The condition may be asymptomatic with no necessity for surgical exploration.

Reproductions of excellent roentgenograms of nine cases accompany the article.—*William H. Shehadi, M.D.*

BERANBAUM, S. L., and SUBBARAO, KAKARLA. The ileo-cecal valve in diseases. *Am. J. Digest Dis.*, Dec., 1955, *22*, 331–335. (From: University Hospital, New York University, Bellevue Medical Center, New York, N. Y.)

The authors discuss the appearance of the ileocecal valve in the following diseases: postoperative adhesions, terminal ileitis, enterocolitis and ulcerative colitis, ileocecal tuberculosis, neoplasms, prolapse and intussusception. These conditions are illustrated by reproductions of roentgenograms.

It is pointed out that whereas the apex of the usual ileocecal valve defect points inwardly toward the lumen of the cecum, in cases of tuberculosis, the apex is directed toward the ileum. This sign, also called the "inverted umbrella" although thought to be quite characteristic of tuberculosis has been observed by the authors in other chronic inflammatory processes involving the valve. This finding is probably not specific for tuberculosis.—*James J. McCort, M.D.*

Lumb, George, Proteroe, H. B., and Ramsay, Gordon S. Ulcerative colitis with dilatation of the colon. *Brit. J. Surg.*, Sept., 1955, *43*, 182–188. (From: Westminster Hospital, London, England.)

Ordinarily ulcerative colitis follows the pattern of increasing superficial mucosal erosion with damage to the colon musculature occurring late. Fibrous replacement and progressive shortening of the total length of the large bowel occurs over a longer period of time. This article draws attention to a small group of cases in which the disease presents as an acute fulminating process producing rapid damage of all coats of the colon wall. Although this process is acute, it does not necessarily occur in the earlier stages of ulcerative colitis. Seven cases are reported and in 4 of these the fulminating process began less than one year after the first symptom, whereas in the other 3 cases it manifested itself more than five years after the onset. In each of these, colonic dilatation was a prominent feature. The 7 cases with reproductions of illustrative roentgenograms and gross and microscopic pathologic specimens are presented.

The general appearance of the colon following operative resection was extensive thinning of the bowel wall in the dilated segments with vascular congestion and a hemorrhagic mucosa. All of the specimens showed evidence of acute perforation or chronic adhesions between the colon and anterior abdominal wall indicating that perforation had occurred at an earlier date. The dilatation may have been generalized but was usually maximal in the transverse colon. In some cases it was localized to one segment consistent anatomically with the most pronounced pathologic findings. Mucosal destruction, muscle destruction, and variable patterns of fibrotic repair were noticed. Vascular dilatation was present but no evidence of inflammatory necrosis of the endothelium could be elicited.

Clinically the process was ushered in by a fulminating course with pain and tenderness accompanying abdominal distention and the signs and symptoms of perforation and peritonitis were present. Diagnosis was not a great problem since sigmoidoscopy with or without biopsy was usually sufficient to establish the underlying process. It is most important to exclude an obstructive cause for the dilatation such as carcinoma. This can best be done by barium contrast study of the colon which would show an absence of a filling defect.

The authors emphasize the recognition of dilatation of the colon as attending a fulminating ulcerative colitis. This condition requires immediate therapeutic attention and represents a violent and dangerous complication of chronic ulcerative disease.—*John W. Wilson, M.D.*

Busson, André, and Morin, Guy. (Paris, France.) Les diverticulites aiguës du sigmoïde et du côlon gauche. (Acute diverticulitis of the sigmoid and left colon.) *Presse méd.*, Dec. 25, 1955, *63*, 1852–1854.

Acute diverticulitis of the left colon is not unusual. One of the authors observed 12 cases in 1953–1954. There is a clear clinical and roentgenologic picture. The physician should be able to warn the radiologist of the probable diagnosis so that the colon is not overdistended.

Medical therapy is usually curative but if surgery is necessary, it should be possible to wait until the infection is completely or largely under control.—*Marcy L. Sussman, M.D.*

Strelinger, A. (Elizabeth, N. J.) Biliary dyssynergia: Report of two cases. *Am. J. Digest. Dis.*, Dec., 1955, *22*, 345–349.

Biliary dyssynergia, also called biliary dyskinesia, is defined by the author as the occurrence of unusual or abnormal reactions on the part of the contractile elements of the extrahepatic biliary tract resulting in discomfort to the patient.

Two cases are reported. In the first there was believed to be intermittent spasm of the sphincter of Oddi resulting in dilatation of the common duct. This was corrected by a side to side anastomosis between the dilated common duct and the duodenum. The second patient was found to have chronic cholecystitis and gallbladder diverticulum. The gallbladder was removed.—*James J. McCort, M.D.*

Batt, Richard C. Intravenous cholecystangiography. *Radiology*, Dec., 1955, *65*, 926–932. (Address: Glens Falls Hospital, Glens Falls, N. Y.)

One hundred cases of intravenous cholecystangiography using cholografin have been studied in order to determine the usefulness, indications and limitations of this procedure. A cholecystectomy had been performed previously in 40 of these patients, while in 60 the gallbladder was still present.

Twenty cc. of the 20 per cent solution was used in the routine cases while twice that amount was necessary in obese and cholecystectomized patients. The technique of the procedure as suggested by the manufacturer of the medium was followed closely.

In the 40 cholecystectomized patients 26 had normal bile ducts; stones were found in 4, and a cystic duct with a "sac" was present in 4. Two were found with a long cystic duct and with the other ducts dilated, 1 had only dilated ducts and there were 2 with no visualization. The so-called postcholecystectomy syndrome is the main indication for this procedure.

In the group of 60 patients with gallbladder disease the bile ducts were outlined in 42 and the gallbladder in 31. Most of these patients had the cholografin examination because determination of the status of the biliary tree was impossible, equivocal, unsatisfactory, or in need of confirmation. Stones

in the gallbladder were found in 11 patients and duct stones were found in 2.

Seventy-one patients had no reaction from the intravenous injection and the incidence of nausea and vomiting was low. Diarrhea, griping, and dysuria were absent. Only 2 patients had severe reactions which occurred despite negative conjunctival and intravenous sensitivity tests. Both responded to administration of adrenalin.

In conclusion the author states that oral cholecystography is the procedure of choice while intravenous cholangiography is indicated in cholecystectomized patients and as a supplementary examination when the oral method is unsuccessful or equivocal.—*Donald N. Dysart, M.D.*

Gynecology and Obstetrics

Granjon, A., Philippe, D., and Beau, A.-M. Allongement et hypertrophie du col. (Lengthening and hypertrophy of the cervix.) *Presse méd.*, Dec. 25, 1955, *63*, 1837–1839. (From: Maternité de l'Hôtel-Dieu, Paris, France.)

With the aid of several beautiful illustrations, both roentgenologic and pathologic, the authors emphasize that supravaginal elongation of the cervix is not infrequent. They urge hysterography and hysterometry be used in the presence of lesions classified as prolapse but by no means defined. These studies should precede and dictate the type of surgery.

Congenital and acquired lesions may be classified as elongation and as true hypertrophy with increase in the diameter of the cervix. The changes may be sub- and/or supra-vaginal. The supravaginal changes are quite frequent and are most often missed on conventional gynecologic examination.—*Marcy L. Sussman, M.D.*

Gentourinary System

Pyrah, L. N., and Raper, F. P. Renal calcification and calculus formation *Brit. J. Urol.*, Dec., 1955, *27*, 333–351. (From: Department of Urology, The University of Leeds and St. James's Hospital, Leeds, England.)

Roentgenograms of 216 supposedly normal kidneys removed at autopsy revealed small parenchymal calcific foci in 10 per cent of the cases. Microscopic examination of 103 pairs of apparently normal kidneys revealed tiny foci of calcification in 21 per cent of the cases. Most of these calcifications lie around the upper collecting tubules and a few lie within the tubules. They may represent past minor pathologic incidents or represent incidents of a vascular nature, the calcific deposit being the end result of healing.

The following diseases are associated with microscopic renal calcification, which is mainly of pathologic interest to the urologist, may cause considerable impairment of renal function and sometimes may cause death, the presumable cause of renal calcification in these diseases being hypercalcemia: 1) Idiopathic hypercalcemia of infants. 2) Osseous metastatic carcinoma. 3) Hypervitaminosis D. 4) Multiple myelomatosis and sarcoidosis.

Another group of diseases is presented in which renal calcification may be associated with calculus formation. The renal calcification is roentgenographically demonstrable in: 1) Renal acidosis including primary renal acidosis in infants, adolescents and adults. 2) Secondary renal acidosis. 3) Primary hyperparathyroidism. The authors list three reasons why calculi of primary hyperparathyroidism are of grave import to the patient: 1) They are certain to recur after operative removal unless the parathyroid adenoma is removed. 2) Long-continued hyperparathyroidism damages the renal parenchyma, producing nephrosclerosis and intrarenal calcification. 3) Sclerotic changes are probably permanent with many patients developing hypertension or dying of renal failure. The diagnosis of hyperparathyroidism is discussed.

The authors describe how gastric conditions such as peptic ulceration can indirectly cause renal damage. Infection, a common cause of stone formation, apparently is not a common cause of calcification within the kidney.—*Claude D. Baker, M.D.*

Stewart, H. Hamilton Calcification and calculus formation in the upper urinary tract. *Brit. J. Urol.*, Dec., 1955, *27*, 352–370. (From: Royal Infirmary, Bradford, England.)

The author presents 154 cases of partial nephrectomy for calycine stones. Revision of his surgical approach is based on the observation that his previous cases of partial nephrectomy involving removal of the lower minor calyx, the most common place for maturation of recurrent calculi, resulted in a decreased recurrence which was limited to the remaining portion of the lower pole. Based on the explanation that primary stone formation is due to the inability of lymphatics to remove intrarenal calcific deposits and that the lower pole is drained by a single lymph trunk, removal of the whole lower pole was performed. Nineteen per cent of the cases involved removal of part or all of the upper pole. Removal of only a superior minor calyx is permissible because of its individual lymph vessel.

Renal stones are classified as primary and secondary. Primary are: 1) Randall's stones formed on calcified plaques on the papillae. 2) Stones with one or more nuclei which are calcium concretions that form in renal tissue and collect in forniceal pouches. These may be due to metabolic disease, thus usually involving all segments. Secondary stones are renal calculi originating in the pelvi-calyceal system and are associated with infection, stasis, recumbency, vitamin deficiency, etc.

The method of determining extent of involvement

is by roentgen examination of the exposed kidney since small calcific bodies are present that will not visualize on preoperative roentgenograms. A special rectangular cone with a sterile linen diaphragm so that the kidney may be raised and immobilized against it is used. A paper cassette contained in a sterile rubber bag is placed in the wound behind the kidney. The changes frequently seen that were not present on preoperative roentgenograms are: 1) residual calculus in a calyx, 2) concretion in a "pouch" or Randall's plaque.

The author has had no recurrence after three years. Treatment of secondary stones, secondary stones associated with primary stones, hemorrhage and infection is discussed.—*J. H. Purcell, M.D.*

Hellström, John. Calcification and calculus formation in a series of seventy cases of primary hyperparathyrodism. *Brit. J. Urol.*, Dec., 1955, *27*, 387–393. (From: Karolinska Hospital, Stockholm, Sweden.)

Seventy cases of primary hyperparathyroidism are analyzed as to renal lesions, skeletal lesions, and a combination of skeletal and renal lesions.

Roentgenographically the renal calcifications are found chiefly in the pyramids but histologically the nephrocalcinosis presents as calcium deposits in the tubular epithelium as well as the interstitial tissue.

The nephrocalcinosis is caused by precipitation of lime salts in the tubules due to disturbances of calcium and phosphorus metabolism, to tubular damage produced by the parathyroid hormone, and possibly,—as recently pointed out by Engel and associates,—due to depolymerisation of the basic substance of bone of which glycoprotein is an important constituent.

Clinically, renal changes are the commonest and most important and the prognosis following parathyroidectomy is mainly dependent on the state of the kidneys at the time of operation. Every case of renal calculi or calcification should be investigated early for hyperparathyroidism.—*John F. Berry, M.D.*

Kobayashi, Osamu, and Sakaguchi, Shigeru. Unilateral renal hypertension in a girl cured by nephrectomy. *J. Pediat.*, Jan., 1956, *48*, 57–62. (From: Department of Pediatrics, Mie Medical College, Tsu City, Japan.)

Although hypertension in bilateral renal disease in children is not rare, unilateral renal hypertension occurs infrequently. A few reports indicate the possibility of recovery from hypertension following early nephrectomy in the event only one kidney is diseased. Only 10 childhood cases have been reported (*J.A.M.A.*, 1949, *139*, 305.) in which the blood pressures had remained at normal levels for at least one year after operation and thus relief of hypertension by nephrectomy is comparatively rare.

A detailed case report is given of a 14-year old girl with hypertension with unilateral chronic pyelonephritis treated by nephrectomy. For two years following the operation, the blood pressure remained normal.

Hypertension in children is usually due to bilateral disease and in only 1 per cent of patients with hypertensive vascular disease has unilateral renal disease been found. According to some authors three kinds of kidney disease must be considered: (1) congenital hypoplasia or aplasia, (2) chronic pyelonephritis, and (3) congenital anomalies of the main renal artery leading to ischemia. Unilateral renal hypertension has been reported in the literature, however, as a result of many obstructive, inflammatory, vascular, and neoplastic disorders of the kidney.

The studies of Goldblatt are briefly discussed in which partial renal ischemia produced experimentally led to the development of hypertension which could be corrected by the removal of the constricted kidney.

Early removal of the diseased kidney is emphasized since irreversible pathologic changes (particularly arteriosclerotic) in the remaining kidney may develop. Cure should not be assumed unless the diastolic pressure remains within normal limits for at least two years. In general the younger the patient and the shorter the duration of the hypertension, the better the result.—*John W. Wilson, M.D.*

Kalmon, Edmond H., Albers, Donald D., and Dunn, J. Hartwell. Ureteral jet phenomenon; stream of opaque medium simulating an anomalous configuration of the ureter. *Radiology*, Dec., 1955, *65*, 933–935. (Address: Dr. Kalmon, 301 N. W. 12th St., Oklahoma City, Okla.)

The authors describe two cases in which unusual urographic findings were observed. These patients had excretory urograms made because of recurrent urinary tract infections, and in both the terminal left ureters appeared to cross the midline and terminate in the region of the trigone on the opposite side of the bladder. Findings on subsequent cystoscopic examination and retrograde pyelography in each case were entirely normal.

It is postulated that the unusual appearance of the terminal ureters was the result of making the roentgenogram just as a bolus of contrast medium was being ejected from the ureteral orifice. This ureteral jet of highly concentrated radiopaque medium streamed across the trigone, giving the appearance of a prolonged ureter opening on the opposite side of the bladder. The age of the patients (5 and $3\frac{1}{2}$), urinary tract infections, and vesical neck obstructions were considered as possible contributing factors.—*A. R. Watson, M.D*

Brunschwig, Alexander, and Daniel, William. Observations on the urinary tract four to seven years after total pelvic exenteration and wet colostomy. *Ann. Surg.*, Oct., 1955, *142*, 729–738 (From: Memorial Center for Cancer and Allied Diseases, New York. N. Y.)

The authors report the urinary tract findings in 19 patients who survived from four to seven and one half years following total pelvic exenteration (12) and anterior pelvic exenteration (7).

Implantation of the ureters was of three types: 1. implantation in end colostomy (wet colostomy)-(12); implantation in intact pelvic colon (5); and 3. bilateral cutaneous implantation (2).

The urinary tract changes were classified as from normal through nonfunction and were divided into five groups, four of which showed varying degrees of hydronephrosis and hydroureter. Three cases showed abnormal urinary tracts prior to operation. After four to seven and one half years 2 of the wet colostomy cases remained normal, the others showed varying degrees of hydronephrosis. In no case did a functioning kidney progress to nonfunction. Pyelograms taken shortly after surgery showed moderate dilatation in all cases, but this was observed to diminish at a later date. In cases having anterior pelvic exenteration with ureteral implantation in the intact colon (6) and cutaneous implantation (2-one case had secondary cutaneous implantation) 3 patients have developed renal calculi; and varying degrees of hydronephrosis have been seen. Both groups have had pyelitis but to a far lesser extent than in the wet colostomy group.

The blood chemistry changes varied showing elevated nonprotein nitrogen, slight decrease in CO_2 combining power and a tendency toward hyperchloremia.

The authors feel that wet colostomy with total pelvic exenteration is the procedure of choice.

The article contains numerous charts and roentgenographic reproductions.—*P. B. Parsons, M.D.*

Nervous System

Chavany, J. A., Carrére, J. Perrin, and Pochard, Marcelle. Sur une variété d'encéphalopathie post-traumatique à évolution subaiguë génératrice de cécité et de troubles psychiques graves et irréductibles. (A type of post-traumatic encephalopathy of subacute development with blindness and severe, irreversible psychic disturbances.) *Presse méd.*, Dec. 25, 1955, *63*, 1840–1842. (From: Clinique Neuro-Chirurgicale de la Pitié, Paris, France.)

Minute and prolonged observation of a sick or wounded patient, with modern techniques, permits an evaluation of the anatomic cause and, to some extent, of pathogenesis. The type of encephalopathy which is discussed is characterized by (1) a free interval between a minimal trauma and the step-like development of complex psychiatric disturbances at the end of the second month, (2) blindness not explained by optic nerve involvement, (3) bioclinical findings.

In the patient whose history is recorded, a subdural hematoma was evacuated. However, the severe lesion was parenchymatous, approaching progressive cerebral atrophy as shown by successive ventriculograms. This was related to an encephalitis which seemed to develop during a febrile episode lasting 15 days and appearing 2½ months after the injury.—*Marcy L. Sussman, M.D.*

Bell, Robert L. Hemangioma of a dorsal vertebra with collapse and compression myelopathy. *J. Neurosurg.*, Nov., 1955, *12*, 570–576 (From: Department of Neurosurgery, State University of New York, College of Medicine, New York City, N. Y.)

Columnation of the vertebral body is commonly interpreted by roentgenologists as hemangioma. This lesion is seldom of clinical importance and autopsy findings of large series of cases have indicated an occurrence of approximately 10 per cent as an incidental finding.

A review of the literature reveals numerous reports of vertebral angiomata, but in only about 60 was associated dysfunction of the spinal cord recorded. Five of these were well-documented examples with slowly developing paresis often progressing to paralysis. Encroachment on the vertebral canal with resultant compression myelopathy may occur as the result of deformation of the centrum subsequent to collapse, extension of the angioma into the regional epidural space, and hypertrophy of the vertebral arch secondary to angiomatous invasion. In addition to these five cases the author lists four patients with compression myelopathy secondary to vertebral angioma, for which therapeutic laminectomy was performed. In one, there was the rare complication of vertebral collapse followed by almost complete disappearance of the centrum. This case is presented in detail.

The course of the case specifically presented serves to caution against overestimating the strength of a vertebra involved by an angioma. Fusion operations, either vertebral or rib, should be given consideration. Partial collapse of a vertebral body involved by an angioma would seem to be a clear indication for a fusion operation. Roentgen therapy following laminectomy is recommended.—*John F. Weigen, M.D.*

Reinhardt, K. Aktuelle Probleme in der Kontrastmitteluntersuchung des Wirbelkanals. (Problems encountered in examination of the spinal canal with contrast media.)

Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis, Dec., 1955, *83*, 809–819. (From: Strahleninstitut der Universitätsklinik im Landeskrankenhaus Homburg an der Saar, Germany.)

In a general way indications and dangers of myelography are presented. Air myelograms are considerably less reliable than myelograms done with radiopaque media. The author prefers the use of abrodil over lipiodol or pantopaque. The last two may lead to complicating oil granulomas and arachnoiditis. Against some objections from clinicians and surgeons that myelography is often not necessary in cases of suspected disk protrusion, the author quotes his statistics which indicate a considerably more reliable localization by myelography than by clinical means.

The technical part of the procedure is gone into. In some instances additional films in extension are made in lateral view; they show sometimes abnormalities not seen on the routine films. It is pointed out that subluxation of the small joints is a sign that may be very valuable. An arachnoiditis due to the prolapse may complicate the roentgen appearance. Discography is a worthwhile diagnostic method which, however, is not to be recommended as a standard procedure. It may be indicated when a single disk is involved and can be used to advantage during the surgical procedure when the disk space can be injected under direct vision.—*Hans W. Hefke, M.D.*

Skeletal System

Bjornson, R. G. B. Developmental anomaly of the lateral malleolus simulating fracture. *J. Bone & Joint Surg.*, Jan., 1956, *38-A*, 128–130. (From: Presbyterian Hospital, New York, N. Y.)

This is a report of two cases with a rare developmental anomaly of the lateral malleolus, diagnosed and treated as a recent fracture. Both cases were youngsters, twelve and sixteen years of age, making the distinction between an old ununited fracture and persistent secondary centers of ossification difficult. However, they had adequate time of immobilization and healing should have been complete, but re-examination showed the deformity to remain.

It is the author's belief that these are rare cases of persisting secondary centers of ossification occurring in unusually large lateral malleoli and with the synchondroses so directed as to cause an increasing tendency toward bifid malleoli with growth.—*Thomas E. Padgett, M.D.*

Ponseti, Ignacio V., and McClintock, Robert. The pathology of slipping of the upper femoral epiphysis. *J. Bone & Joint Surg.*, Jan., 1956, *38-A*, 71–83. (From: Department of Orthopaedic Surgery, State University of Iowa, Iowa City, Iowa.)

Core biopsies were done in 3 patients with early slipping of the upper epiphysis.

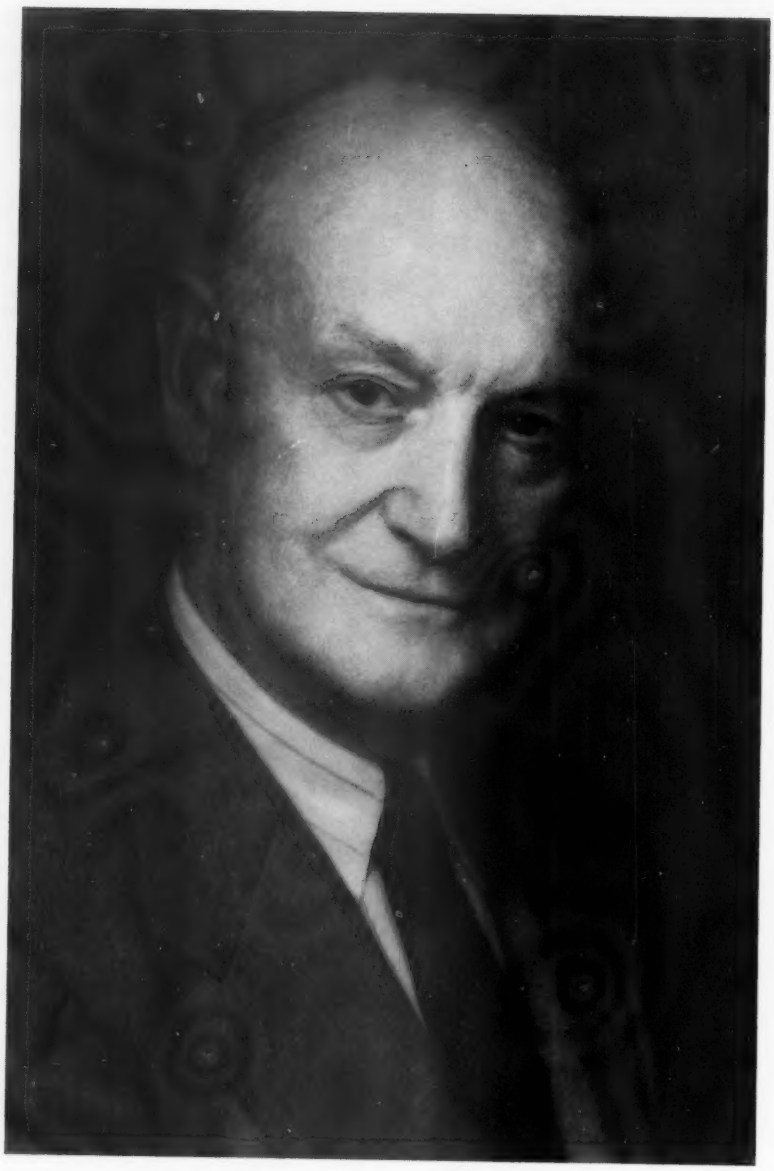
The epiphyseal plate was wide and greatly disrupted and the rows of proliferating cartilage cells were disorganized. The cartilage matrix seemed to have lost its cohesion, and large clefts occurred in areas of the plate, some of which contained necrotic debris. The cartilage cells were grouped in clusters and islands of cartilage cells.

The authors presume that the primary lesion is loss of cohesion of the cartilage matrix due to alteration in the chemical composition of the ground substance. This epiphyseal plate lesion causes loss of strength of the plate with resultant slipping.

Skeletal surveys of patients with slipped upper femoral epiphyses have shown irregularities and widening of other epiphyseal plates.

Studies for serum calcium, phosphorus, alkaline phosphatase, protein bound iodine and plasma albumin and globulin were normal. Serum Vitamin E levels were low. Chromatographic patterns of urinary amino acids showed high values for taurine, histidine and serine. The total amino-acid nitrogen values were not abnormal. These changes are similar to those in patients with adolescent scoliosis.

The epiphyseal plate lesions resemble the lesions seen in experimental animals fed small amounts of aminonitrides. From the authors' animal experiments they suggest that the same changes occur in the epiphyseal line in slipped epiphyses and Perthes' disease.—*Martha Mottram, M.D.*



ARTHUR C. CHRISTIE
EDITOR
1924-1930